U.S. Department
of Transportation
**Federal Aviation
Administration**

Guidelines and Procedures for Maintenance of Airport Pavements

AC: 150/5380-6
Date: 12/3/82

Advisory Circular

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Subject: GUIDELINES AND PROCEDURES FOR MAINTENANCE OF AIRPORT PAVEMENTS

Date: 12/3/82
Initiated by: AAS-200

AC No: 150/5380-6
Change:

1. PURPOSE. This advisory circular (AC) provides guidelines and procedures for maintenance of rigid and flexible airport pavements.

2. FOCUS.

a. Poor maintenance of airport pavements is the result of a variety of causes, among which are lack of funds, untrained personnel, and lack of adequate information. This AC provides specific guidelines and procedures for maintaining airport pavements and establishing an effective maintenance program. Specific types of distress, their probable causes, inspection guidelines, and recommended methods of repair are discussed.

b. This information has been developed to assist airport managers, engineers, and maintenance personnel responsible for pavement design, performance, maintenance, and repair. It is intended primarily for use at small- and medium-size airports that may lack the technical support of an adequate well-trained engineering/maintenance staff or the financial resources to retain a pavement consultant.

3. RELATED READING MATERIAL. The publications listed in Appendix C, Bibliography, provide further guidance and technical information.

Leonard E. Mudd

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Director, Office of Airport Standards

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CHAPTER 1. INTRODUCTION

1. PURPOSE. In operating and maintaining an airport, managers and technical/maintenance personnel are continually faced with problems involving pavement distress and deterioration. To assist them in undertaking preventive and remedial maintenance, this advisory circular (AC) provides information on the various types of pavement distress together with recommended corrective actions. It also contains guidelines for conducting preventive maintenance inspections.

2. BACKGROUND.

a. The aviation community has a large investment in airport pavements. The major objective in the design and construction of these pavements is to provide adequate load-carrying capacity and to provide good ride-quality, permitting safe operation of aircraft under all weather conditions. Immediately upon completion of construction, airport pavements begin a gradual deterioration which is attributable to several factors. Normal distresses in the pavement structure result from surface weathering, fatigue effects, poor drainage, and differential movement in the underlying subbase over a period of years. In addition, faulty construction techniques, substandard materials, or poor workmanship can accelerate the pavement deterioration process. Consequently, there is a continual requirement to perform routine maintenance, rehabilitation, and upgrading of existing airport pavements.

b. Many pavements were not designed for servicing today's aircraft which impose loads much greater than those initially considered for design. Also, there may have been a considerable increase in the frequency of takeoffs and landings. Both of these factors result in accelerated deterioration of pavement structure. Thus, special efforts must be made to upgrade and maintain pavement serviceability to assure safe airport operations.

c. The most effective means of preserving airport runways, taxiways, and apron pavement areas is the implementation of a comprehensive maintenance program. Such a program is a coordinated, budgeted, and systematic approach to both preventive and remedial maintenance. A number of airports have developed this concept and have experienced tangible benefits. A carefully constructed maintenance program should be developed annually, featuring a time schedule and listing equipment and products required. The repairs should be made systematically each year to the extent necessary. An advantage of such a systematic approach is that it assures continual vigilance and permits materials to be stockpiled, thereby assuring that they will be available when needed. Asphalt patching materials, cements, sealers, and crack fillers can be stocked year round for emergencies, as well as for routine scheduled maintenance.

d. Two major elements contributing to pavement deterioration are the gradual effects of weathering and the action of aircraft traffic. If routine maintenance is not performed during the early stages of deterioration, extensive repairs may be required at a later date. This type of neglect is costly, not only in terms of dollars, but also in terms of shutdown time. Therefore, early detection and repair of pavement defects is, without doubt, the most important preventive maintenance procedure. Cracks and other surface defects, which at their early stages are almost unnoticeable, may develop into serious pavement distresses if not repaired. In all cases of pavement distress manifestations, the causes of the problem should first be determined. Repairs can then be made which will not only correct the present damage but will also prevent or retard its progressive occurrence.

e. The selection of a specific rehabilitation method involves both economic and engineering considerations. In the maintenance and repair of airport pavements, the long-term effects, rather than an immediate short-term remedy, should be considered. The cost of several rehabilitation alternatives should be compared over some finite period of time (life cycle). In addition to the initial rehabilitating maintenance costs, all economic consequences of a given repair method, both present and future, should be considered.

f. The present or immediate costs of a pavement rehabilitation/maintenance project includes actual costs of the repairs together with the estimated costs that will be incurred as a result of the project by airport and the airport users (airlines, fixed base operators, etc.) through traffic delays, reroutings, etc. Future costs involve those similar costs that will be incurred at later dates during the life-cycle period (depending on the life expectancy of the repair) plus the routine maintenance costs anticipated over the same period. A comparative analysis of these costs for the various alternatives will indicate the rehabilitation scheme that is the most economical.

CHAPTER 2. AIRPORT PAVEMENTS: COMPOSITION AND FUNCTION

3. INTRODUCTION. Airport pavements are designed, constructed, and maintained to support the critical loads imposed on the pavement and to produce a smooth and safe riding surface. The pavement must be of such quality and thickness that it will not fail under the loads imposed and be sufficiently durable to withstand the abrasive action of traffic, adverse weather conditions, and other deteriorating influences. In order to ensure the necessary strength of the pavement and to prevent unmanageable distresses from developing, various design, construction, and material-related parameters must be considered. To assess such parameters, this chapter provides information on the composition of pavement sections and the functional aspects of flexible and rigid pavement components.

4. CLASSIFICATION. Generally, pavements may be divided into the following three classes:

a. Rigid pavements,

b. Flexible pavements, and

c. Overlays.

Combinations of different pavement types and stabilized layers constitute complex pavements which can be classified as variations of the normal rigid and flexible types.

5. RIGID PAVEMENTS. Rigid pavements normally involve the use of portland cement concrete (PCC) as the prime structural element. Depending upon conditions, the pavement slab may be designed with plain, lightly reinforced, continuously reinforced, prestressed, or fibrous concrete. The concrete slab is usually placed on a compacted granular or treated subbase which, in turn, is supported by a compacted subgrade. The subbase provides uniform stable support and may also provide subsurface drainage. The concrete slab has considerable flexural strength and spreads the applied loads over a large area. Typical rigid pavement structure is illustrated in figure 1. Rigid pavements possess a high degree of rigidity. This rigidity and resulting beam action enables rigid pavements to distribute loads over large areas of the subgrade as shown in figure 2. For better pavement performance, it is important that support for the concrete slab is uniform. Rigid pavement construction strength is most economically built into the concrete slab itself with optimum use of low-cost materials under the slab.

a. Concrete Slab (Surface Layer). The purpose of the concrete slab is to provide a skid-resistant surface, prevent the infiltration of surface water, and provide structural support to the aircraft.

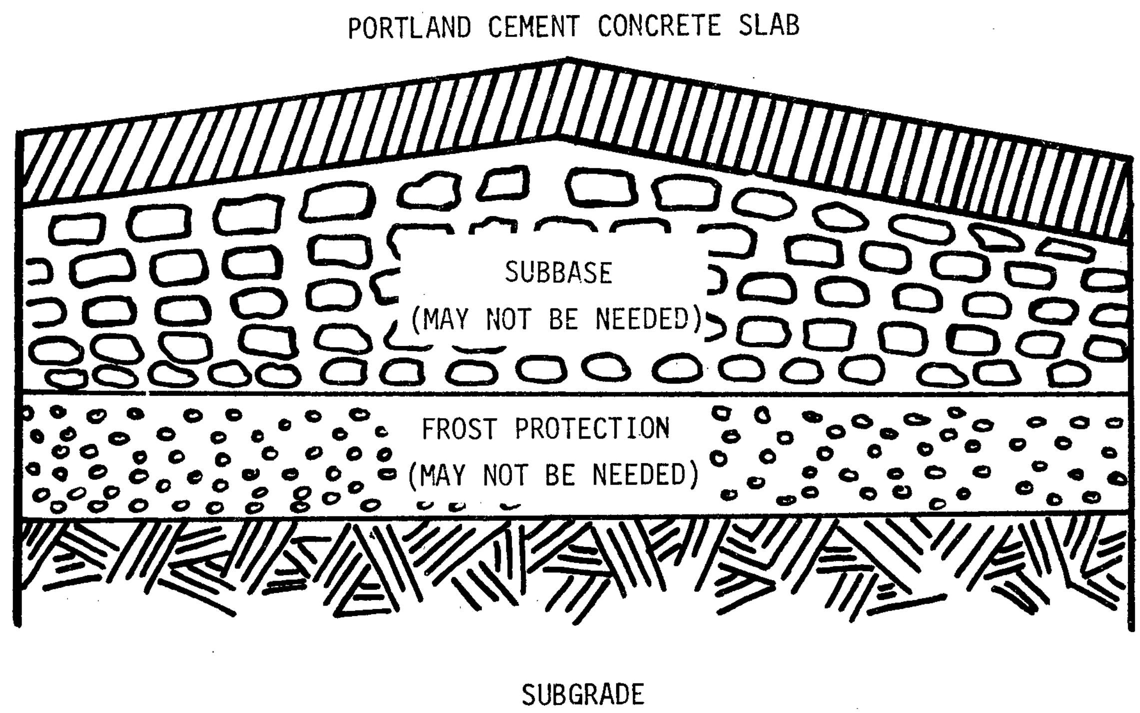


Figure 1. Typical rigid pavement structure.

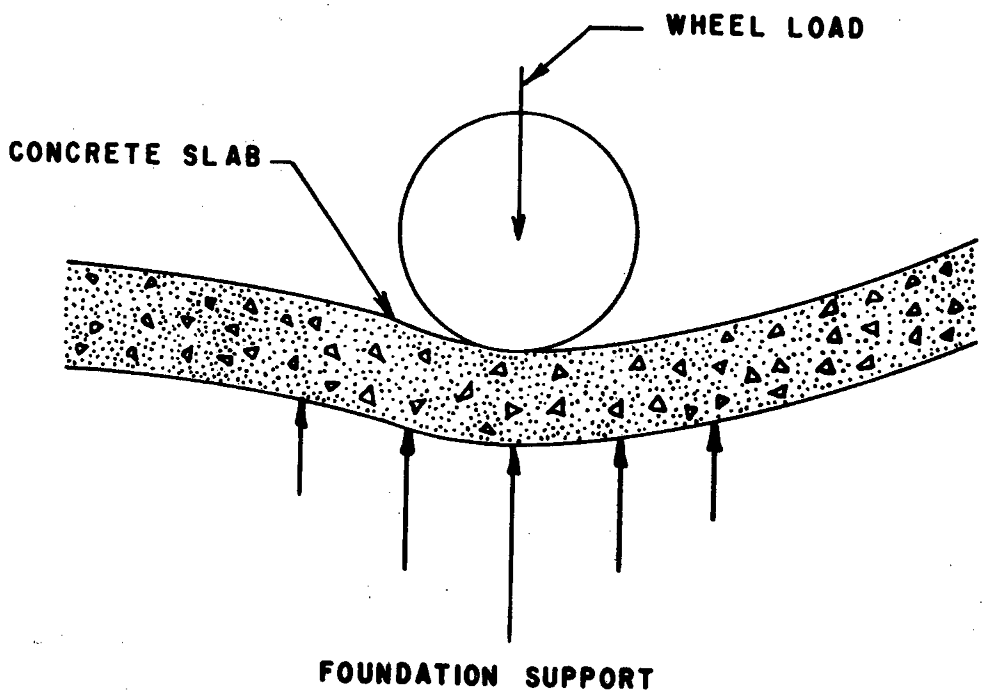


Figure 2. Transfer of wheel load to foundation in rigid pavement structure.

b. Subbase. The purpose of the subbase is to provide uniform stable support for the pavement slab. A minimum subbase thickness of 4 inches (100 mm) is generally required under rigid pavements. Other functions of the subbase are to (1) control frost action, (2) provide subsurface drainage, (3) control swell of subgrade soils, and (4) to prevent mud-pumping of fine grained soils.

c. Stabilized Subbase. A stabilized subbase is required for all new rigid pavements designed to accommodate aircraft weighing 100,000 pounds (45 350 kg) or more. The structural benefit imparted to a pavement section by a stabilized subbase is reflected in the modulus of subgrade reaction assigned to the foundation.

d. Frost Protection Layer. Frost action is an important environmental consideration in areas where there are freezing temperatures and frost-susceptible soil with a high ground water table. Frost action includes both frost heave and loss of subgrade support during the frost-melt period. Frost heave may cause a portion of the pavement to rise due to nonuniform formation of ice crystals in a frost-susceptible material (see figure 3). Thawing of the frozen soil and ice crystals during the spring period may cause pavement damage under loads. The main purpose of the frost protection layer is to function as a barrier against frost action and frost penetration into the lower frost-susceptible layers.

e. Subgrade. The subgrade is the compacted soil layer which forms the foundation for the pavement system. Subgrade soils are subjected to lower stresses than the surface and subbase courses. These stresses decrease with depth, and the controlling subgrade stress is usually at the top of the subgrade unless unusual conditions exist. Unusual conditions, such as a layered subgrade or sharply varying water content or densities, may change the locations of the controlling stress. These conditions are checked during the soils investigation. The pavement above the subgrade must be capable of reducing stresses imposed on the subgrade to values which are sufficiently low to prevent excessive distortion or displacement of the subgrade soil layer. Since subgrade soils vary considerably, the interrelationship of texture, density, moisture content, and strength of subgrade material is complex. The ability of a particular soil to resist shear and deformation will vary with its density and moisture content. In this regard, the soil profile of the subgrade requires careful examination. The soil profile is the vertical arrangement of layers of soils, each of which may possess different properties and conditions. Soil conditions are related to the ground water level, presence of water-bearing strata, and the properties of the soil, including soil density, moisture content, and frost penetration. Since the subgrade soil supports the pavement and the loads imposed on the pavement surface, it is critical to investigate soil conditions to determine their effect on grading and paving operations, and the necessity for underdrains.

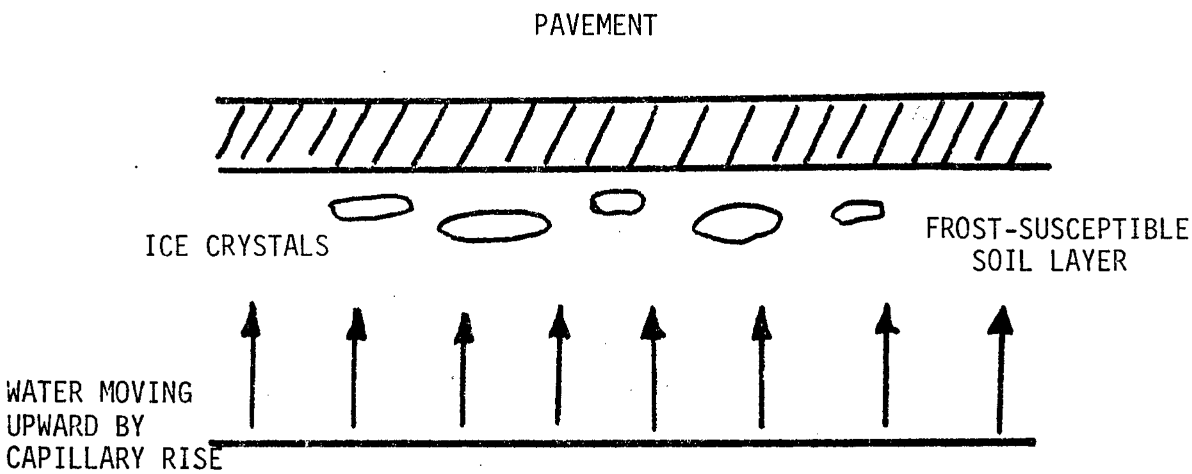


Figure 3. Formation of ice crystals in the soil.

6. FLEXIBLE PAVEMENTS. Flexible pavements support loads through bearing rather than flexural action. They are comprised of several layers of carefully selected materials designed to gradually distribute loads from the pavement surface to the layers underneath. The design is such that the load transmitted to each successive layer does not exceed the layer's load-bearing capacity. A typical flexible pavement section is shown in figure 4. Figure 5 depicts the distribution of the imposed load to the subgrade. The various layers comprising a flexible pavement and the functions they perform are described below:

a. Bituminous Surface (Wearing Course). The bituminous surface, or wearing course, is comprised of a mixture of various selected aggregates bound together with asphalt cement, heavy grades of tars, or other bituminous binders. Its function is to prevent the penetration of surface water to the base course, provide a smooth, well-bonded surface free from loose particles (which might endanger aircraft or persons), resist the stresses developed as a result of aircraft loads, and furnish a skid-resistant surface without causing undue wear on tires.

b. Base Course. The base course is the principal structural component of the flexible pavement. It functions to distribute the imposed wheel load to the pavement foundation, the subbase and/or subgrade. The base course must be designed of a quality and thickness to prevent failure in the subgrade and/or subbase, withstand the stresses produced in the base itself, resist vertical pressures that tend to produce consolidation and result in distortion of the surface course, and resist volume changes caused by fluctuations in its moisture content. The materials comprising the base course are select hard and durable aggregates which generally fall into two main classes: stabilized and granular. The stabilized bases normally consist of crushed or uncrushed aggregate that has been bound with a stabilizer such as cement or bitumen. The quality of the base course is a function of its composition, physical properties, and compaction of the material.

c. Subbase. This layer is used in areas where frost action is severe or in locations where the subgrade soil is extremely weak. The function of the subbase course is similar to the base course. The material requirements for the subbase are not as strict as those for the base course since the subbase is subjected to lower load stresses. The subbase consists of stabilized or granular material properly compacted.

d. Frost Protection Layer. A frost protection layer may be required in a flexible pavement. Its function is the same in either a flexible or a rigid pavement. (See paragraph 5d.)

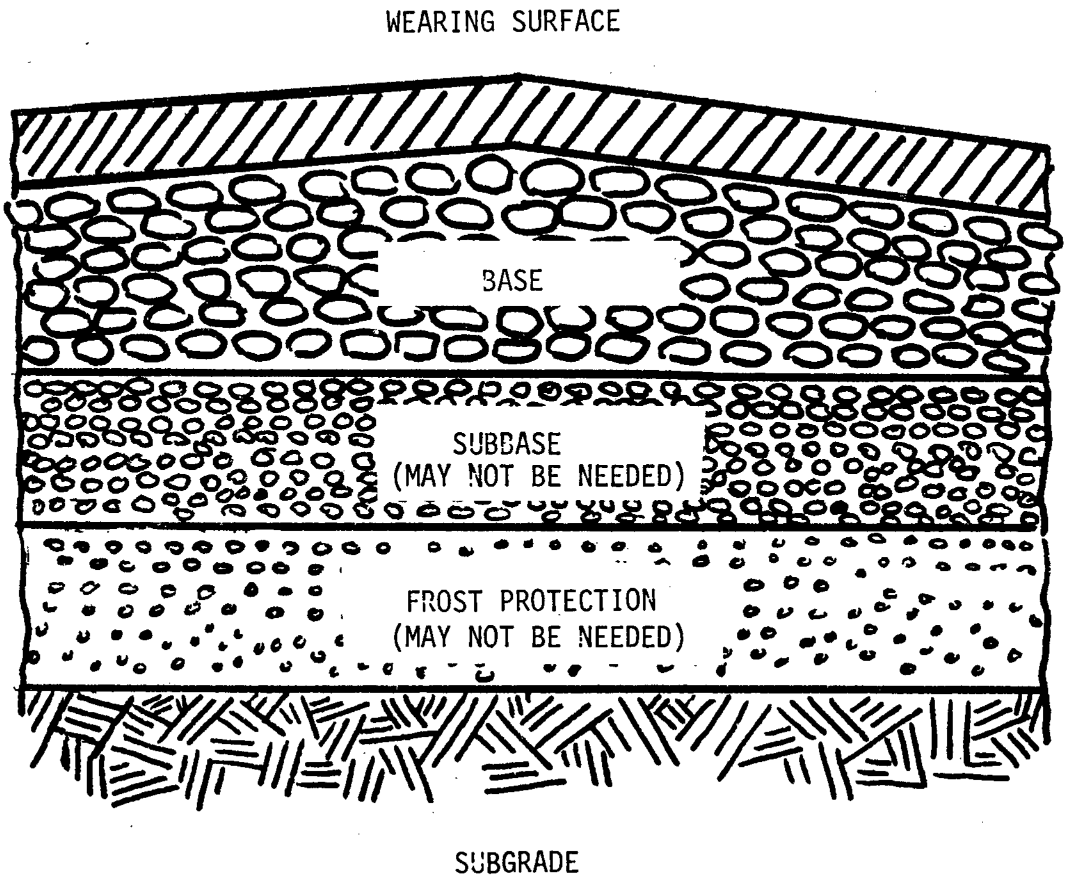


Figure 4. Flexible pavement structure.

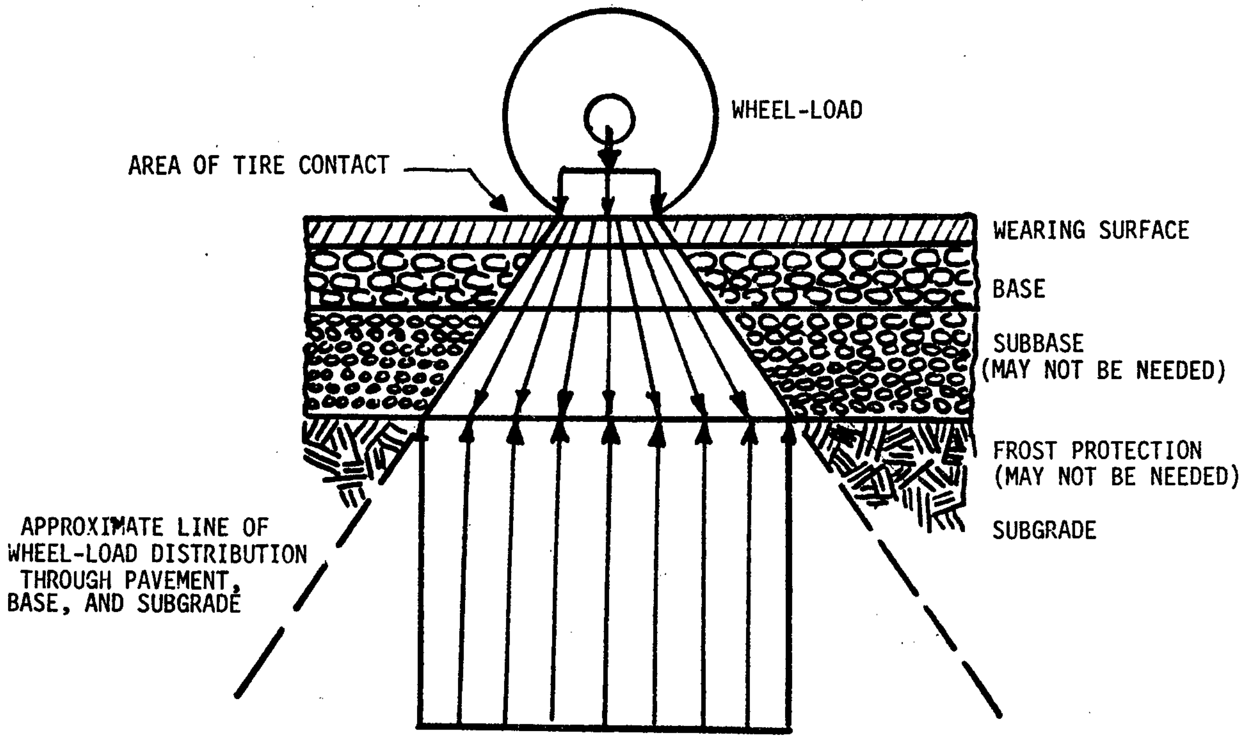


Figure 5. Distribution of load stress in flexible pavement design.

e. Subgrade. The subgrade is the compacted soil layer which forms the foundation for the pavement system. Subgrade soils are subjected to lower stresses than the surface, base, and subbase courses. Since load stresses decrease with depth, the controlling subgrade stress is usually at the top of the subgrade. The combined thickness of subbase, base, and wearing surface must be great enough to reduce the stresses occurring in the subgrade to values which will not cause excessive distortion or displacement of the subgrade soil layer. Factors affecting subgrade behavior are discussed in paragraph 5e.

7. AIRPORT PAVEMENT OVERLAYS. Airport pavement overlays are usually undertaken to correct deteriorating pavement surfaces, to improve ride quality or surface drainage, to maintain the structural integrity, or to increase pavement strength. For instance, a pavement may have been damaged by overloading; it may require strengthening to serve heavier aircraft; uneven settling may have caused severe puddling; or the original pavement simply may have served its design life and is worn out. Generally, airport pavement overlays consist of either portland cement concrete or bituminous concrete.

CHAPTER 3. PAVEMENT DISTRESS

8. GENERAL. The deterioration of a pavement, be it runway or highway, manifests itself by various external signs or indicators which can be associated with the probable causes of the failure or imperfection. This chapter provides a detailed discussion and description of the types of pavement distress relating them to the likely causal factors. Photographs depicting the various types of pavement distress are contained in appendix B, which has been extracted from Report No. FAA-RD-80-55, Procedures for Condition Survey of Civil Airports, dated May 1980.

9. DISTRESS MANIFESTATIONS. The discussions of problems related to pavement distress are generally based on the pavement type; concrete or bituminous. However, while each possesses its own particular characteristics, the various pavement distress manifestations for bituminous and concrete pavements generally fall into one of the following broad categories:

a. Cracking,

b. Distortion,

c. Disintegration, or

d. Skid resistance.

10. CONCRETE PAVEMENTS.

a. Cracking. Cracks in concrete pavements often result from stresses caused by contraction or warping of the pavement. Overloading, loss of subgrade support, insufficient and/or improperly cut joints acting singularly or in combination are also possible causes.

(1) Longitudinal, Transverse, and Diagonal Cracks. These types of distress are usually caused by a combination of repeated loads and shrinkage stresses and are characterized by cracks which divide the slab into two or more pieces.

(2) Corner Cracks. Load repetition, combined with loss of support and curling stresses, usually causes corner cracks. The lack of support may be caused by pumping or loss of load transfer at the joint. This type of break is characterized by a crack that intersects the joints at a distance less than or equal to one-half of the slab length on both sides, measured from the corner of the slab. A corner crack differs from a corner spall in that the crack extends vertically through the entire slab thickness, while a corner spall intersects the joint at an angle.

(3) "D" Cracking. "D" cracking usually appears as a pattern of cracks running in the vicinity of and parallel to a joint or linear crack. It is caused by the concrete's inability to withstand environmental factors such as freeze-thaw cycles in the presence of variable expansive aggregates. This type of cracking may eventually lead to disintegration of the concrete within 1 to 2 feet (30 to 60 cm) of the joint or crack.

(4) Joint Seal Damage. Joint seal damage is any condition which enables soil or rocks to accumulate in the joints or allows infiltration of water. Accumulation of materials prevents the slabs from expanding and may result in buckling, shattering, or spalling. Typical types of joint seal damage include stripping of joint sealant, extrusion of joint sealant, hardening of the filler (oxidation), loss of bond to the slab edges, and absence of sealant in the joint. Joint seal damage is caused by improper joint width, use of the wrong type of sealant, incorrect application, and/or not cleaning the joint properly before sealing.

b. Disintegration. Disintegration is the breaking up of a pavement into small, loose particles and is caused by improper curing and finishing of the concrete, unsuitable aggregates, and improper mixing of the concrete. It also includes dislodging of aggregate particles.

(1) Scaling, Map Cracking, and Crazing. Map cracking or crazing refers to a network of shallow hairline cracks that extend only through the upper surface of the concrete. Crazing usually results from improper curing and/or finishing of the concrete and may lead to scaling of the surface. Scaling is the disintegration and loss of the wearing surface. Scaling may also be caused by a weakened surface caused by improper curing or finishing, freeze-thaw cycles, and unsuitable aggregate.

(2) Joint Spalling. Joint spalling often results from excessive stresses at the joint or crack caused by infiltration of incompressible materials. Weak concrete at the joint (caused by overworking) combined with traffic loads is another cause of spalling. Joint spalling is the breakdown of the slab edges within 2 feet (60 cm) of the side of the joint. A joint spall usually does not extend vertically through the slab but intersects the joint at an angle.

(3) Corner Spalling. Corner spalling is the raveling or breakdown of the slab within approximately 2 feet (60 cm) of the corner. It differs from a corner break in that the spall usually angles downward to intersect the joint, while a break extends vertically through the slab.

(4) Blowups. A blowup usually occurs at a transverse crack or joint. It generally occurs in hot weather, usually at a transverse crack or joint that is not wide enough to permit expansion of the concrete slabs. Insufficient width is usually caused by infiltration of incompressible materials into the joint space. When expansion cannot relieve enough pressure, a localized upward movement of the slab edges (buckling) or shattering will occur in the vicinity of the joint. Blowups normally occur only in thin pavement sections.

(5) Shattered Slab. A shattered slab is defined as a slab where intersecting cracks break up the slab into four or more pieces. This is caused by overloading and/or inadequate foundation support.

c. Distortion. Distortion is a change in the pavement surface from its original position and results from foundation settlement, expansive soils, frost susceptible soils, or loss of fines through improperly designed subdrains or drainage systems.

(1) Pumping. Pumping is characterized by the ejection of material by water through joints or cracks, caused by deflection of the slab under passing loads. As the water is ejected, it carries particles of gravel, sand, clay, or silt resulting in a progressive loss of pavement support that can lead to cracking. Surface staining and base or subgrade material on the pavement close to joints or cracks are evidence of pumping. Pumping near joints indicates a poor joint seal and the presence of ground water.

(2) Settlement or Faulting. Settlement or faulting is a difference in elevation at a joint or crack caused by upheaval or differential consolidation. This condition may result from loss of fines, from frost heave, or from swelling soils.

d. Skid Resistance. Skid resistance refers to the ability of a pavement to provide a surface with good friction characteristics under all weather conditions and is a function of the surface texture or the buildup of contaminants.

(1) Polished Aggregates. Some aggregates will become polished quickly under traffic. Others are naturally polished and will be a skid hazard if used in the pavement without crushing.

(2) Contaminants. Rubber deposits building up over a period of time will reduce the surface friction characteristics of a pavement.

11. BITUMINOUS PAVEMENTS.

a. Cracking. Cracks in bituminous pavements are caused by deflection of the surface over an unstable foundation, shrinkage of the surface, poorly constructed lane joints, or reflection cracking.

(1) Longitudinal and Transverse Cracks. Longitudinal and transverse cracks are caused by shrinkage of the bituminous concrete surface. Longitudinal cracks are also caused by poorly constructed lane joints.

(2) Alligator or Fatigue Cracking. Alligator cracks are interconnected cracks that form a series of small blocks resembling an alligator skin. They may be caused by fatigue failure of the bituminous surface under repeated loading or by excessive deflection of the surface over an unstable foundation. The unstable support is usually the result of water saturation of the bases or subgrade.

(3) Block Cracking. Block cracking is caused by shrinkage of the asphalt concrete and daily temperature cycling (which results in daily stress/strain cycling). These are interconnected cracks that divide the pavement into approximately rectangular pieces. The occurrence of this type of distress usually indicates that the asphalt has hardened significantly. Block cracking generally occurs over a large portion of the pavement area and may sometimes occur only in nontraffic areas.

(4) Slippage Cracks. Slippage cracks are caused by braking or turning wheels causing the pavement surface to slide and deform. This usually occurs when there is a low-strength surface mix or poor bond between the surface and the next layer of pavement structure. These cracks are crescent or half-moon-shaped cracks having two ends pointed away from the direction of traffic.

(5) Reflection Cracking. Reflection cracks are caused by vertical or horizontal movements in the pavement beneath an overlay, brought on by expansion and contraction with temperature and moisture changes. These cracks in asphalt overlays reflect the crack pattern in the underlying pavement. They occur most frequently in asphalt overlays on portland cement concrete pavements. However, they may also occur on overlays of asphalt pavements wherever cracks in the old pavement have not been properly repaired.

b. Disintegration. Disintegration in a bituminous pavement is caused by insufficient compaction of the surface, insufficient asphalt in the mix, or overheating of the mix.

(1) Raveling. Raveling is the wearing away of the pavement surface caused by the dislodging of aggregate particles and loss of asphalt binder. As the raveling continues, larger pieces are broken free, and the pavement takes on a rough and jagged appearance.

c. Distortion. Distortion in bituminous pavements is caused by foundation settlement, insufficient compaction of the pavement courses, lack of stability in the bituminous mix, poor bond between the surface and the underlying layer of the pavement structure, or swelling soils or frost action in the subgrade.

(1) Rutting. A rut is characterized as a surface depression in the wheel path. In many instances, ruts are noticeable only after a rainfall when the wheel paths are filled with water. This type of distress is caused by a permanent deformation in any of the pavement layers or subgrade and is caused by consolidation of the materials due to traffic loads.

(2) Corrugation and Shoving. Corrugation results from a form of plastic surface movement typified by ripples across the surface. Shoving is a form of plastic movement resulting in localized bulging of the pavement surface. Corrugation and shoving can be caused by lack of stability in the mix and poor bond between material layers.

(3) Depression. Depressions are localized low areas of limited size. In many instances, light depressions are not noticeable until after a rain, when ponding creates "birdbath" areas. Depressions can be caused by traffic heavier than that for which the pavement was designed, by localized settlement of the underlying pavement layers, or by poor construction methods.

(4) Swelling. Swelling is characterized by an upward bulge in the pavement's surface. It may occur sharply over a small area or as a longer gradual wave. Both types of swell may be accompanied by surface cracking. A swell is usually caused by frost action in the subgrade or by swelling soil.

d. Skid Resistance. Factors which decrease the skid resistance of a pavement surface and can lead to hydroplaning include: too much asphalt in the bituminous mix; too heavy a prime coat; poor aggregate subject to wear; and buildup of contaminants.

(1) Bleeding. Bleeding is characterized by a film of bituminous material on the pavement surface which resembles a shiny, glass-like, reflecting surface that usually becomes quite sticky. It is caused by excessive amounts of asphalt cement or tars in the mix and/or low air-void content and occurs when asphalt fills the voids of the mix during hot weather and then expands out onto the surface of the pavement. Since the bleeding process is not reversible during cold weather, asphalt or tar will accumulate on the surface. Extensive bleeding may cause a severe reduction in skid resistance.

(2) Polished Aggregate. Aggregate polishing is caused by repeated traffic applications. It occurs when the aggregate extending above the asphalt is either very small, of poor quality, or contains no rough or angular particles to provide good skid resistance.

(3) Fuel Spillage. Continuous fuel spillage on a bituminous surface will soften the asphalt. Areas subject to only minor fuel spillage will usually heal without repair, and only minor damage will result.

(4) Contaminants. An accumulation of rubber over a period of time will reduce the skid resistance of a pavement.

12. DRAINAGE.

a. A proper drainage system is a fundamental consideration of preventive maintenance. Pavement failures should always be investigated for deficient drainage. Probably no other factor plays such an important role in determining the ability of a pavement to withstand the effects of weather and traffic. The purpose of airport drainage is to dispose of the water which may hinder activity necessary to the safe and efficient operation of the airport. The drainage system collects and removes surface water runoff, removes excess underground water, lowers the water table, and protects all slopes from erosion. An inadequate drainage system can cause saturation of the subgrade and subbase, damage to slopes by erosion, and loss of the load-bearing capacity of the paved surfaces.

b. The damage mechanism of free water in the pavement system is related to the amount of free water in the boundaries between the structural layers of the pavement system. When water fills the voids and spaces at the boundaries between layers, heavy wheel loads applied to the surface of the pavement produce impacts on the water that are comparable to a water-hammer type of action. The resulting water pressure causes erosion of the pavement structure and ejection of material out of the pavement.

c. There are two general classes of drainage systems, surface and subsurface. Classification depends on whether the water is on or below the surface of the ground at the point where it is first intercepted or collected for disposal. Where both types of drainage are required, it is generally good practice for each system to function independently.

(1) Surface Drainage. The purpose of surface drainage is to control and collect water from rainstorms and melting snow and ice. Surface drainage of pavements is achieved by constructing the pavement surface to allow for adequate runoff. Surface water may be collected at the edges of the paved surface in ditches, gutters, and catch basins. Surface drainage includes the disposal of all water present on the surface of the pavement and nearby ground. Surface water should not be allowed to enter a subdrainage system as it often contains soil particles in suspension. These particles tend to deposit as the water percolates through the granular material of the subdrain causing it to silt up. Inevitably, some water will enter the pavement structure through cracks, open joints, and other surface openings, but this may be kept to a minimum by proper surface maintenance procedures.

(2) Subsurface Drainage. Subsurface drainage is provided for the pavement by a highly permeable layer of sand-aggregate mixture under the full width of the traveled way, with longitudinal pipes for collecting the water, and outlet pipes for rapid removal of the water from the subsurface drainage system. It removes excess water from pavement foundations to prevent weakening of the base and subgrade and to reduce damage from frost action.

d. Additional guidance and technical information is contained in AC 150/5320-5, Airport Drainage, current edition.

CHAPTER 4. GUIDELINES FOR INSPECTION OF PAVEMENTS

13. INTRODUCTION. A high priority should be given to the upkeep and repair of all pavement surfaces in the aircraft operating areas of the airport to ensure continued safe aircraft operations. While deterioration of the pavements due to usage and exposure to the environment cannot be completely prevented, a timely and effective maintenance program can reduce this deterioration to a minimum level. Lack of adequate and timely maintenance is the greatest single cause of pavement deterioration. Many cases are known where failures of airport pavements and drainage features were directly attributed to inadequate maintenance characterized by the absence of a vigorously followed inspection program. It should be noted that maintenance, no matter how effectively carried out, cannot overcome or compensate for a major design or construction inadequacy. It can, however, prevent the total and possibly disastrous failure which may result from such deficiencies. The maintenance inspection can reveal at an early stage where a problem exists and thus provide the warning and time to permit corrective action. Postponement of minor maintenance can develop into a major pavement repair project. This chapter presents guidelines and procedures for inspection of airport pavements.

14. INSPECTION PROCEDURES. Maintenance is a continuous function and is the responsibility of airport personnel. A series of scheduled, periodic inspections or surveys, conducted by experienced engineers, technicians, or maintenance personnel, must be carried out in a truly effective maintenance program. These surveys must be controlled to ensure that each element or feature being inspected is thoroughly checked, that potential problem areas are identified, and that proper corrective measures are recommended. The maintenance program must provide for adequate follow-up of the inspection to ascertain that the corrective work is expeditiously accomplished and recorded. Although the organization and scope of maintenance activities will vary in complexity and degree from airport to airport, the general types of maintenance are relatively the same regardless of airport size or extent of development.

a. Inspection Schedules. The supervisor of airport maintenance is responsible for establishing a schedule for inspections. The inspection should be scheduled to ensure that all areas, particularly those which may not come under day-to-day observation, are thoroughly checked. Thorough inspections of all paved areas should be scheduled at least twice a year. In temperate climates, one inspection should be scheduled for spring and one for fall. Any severe storms or other conditions which may have an adverse effect on the pavement may also necessitate a thorough inspection. In addition, everyday ride-down type inspections should be conducted.

b. Recordkeeping. Complete information concerning all inspections and maintenance performed should be recorded and kept on file. The severity level of existing distress types, their locations, their probable causes, remedial actions, and results of follow up inspection and maintenance should be documented. In addition, the file should contain information on potential problem areas and preventive or corrective measures identified. Records of materials and equipment used to perform all maintenance and repair work should also be kept on file for future reference. Such records may be used later in identifying materials and remedial measures which may reduce maintenance costs and improve pavement serviceability. A suggested procedure for performing a pavement condition survey is contained in appendix A, which has been extracted from Report No. FAA-RD-80-55 (see paragraph 8 and Bibliography). The pavement condition survey in conjunction with the Pavement Condition Index (PCI) may be used to develop pavement performance data. The PCI is a rating of the surface condition of a pavement and is a measure of functional performance with implications of structural performance. Periodic PCI determinations on the same pavement will show the change in performance level with time.

15. FRICTION SURVEYS. Runway pavements should be maintained to provide surfaces with good friction characteristics under all weather conditions. Parameters which affect the skid resistance of wet pavement surfaces include the following:

a. Texture depth,

b. Rubber deposits,

c. Paint marking, and

d. Pavement abnormalities such as rutting, raveling, and depression.

Observations made during the pavement inspection will help determine if a friction survey is required. Guidance on conducting friction surveys is contained in AC 150/5320-12, Methods for the Design, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces, current edition.

16. NONDESTRUCTIVE TESTING. In addition to visual inspection of the pavement area and information on runway history, data from nondestructive testing is desirable. Such data are used to evaluate the pavement load-carrying capacity. Vibratory loads are applied to the pavement through loading plates or wheels, and the pavement deflection response is recorded. The stiffness or strength of the airport pavement can be related to the magnitude of these deflections. Nondestructive testing involves a large number of readings, and a statistical average is used. Details for taking the measurements and evaluating the test results to determine the load-carrying capacity of the pavement structure are contained in AC 150/5370-11, Use of Nondestructive Testing Devices in the Evaluation of Airport Pavements, current edition.

17. DRAINAGE SURVEYS. Adequate drainage of surface and ground water is an important consideration in the maintenance of airport pavements since water is directly or partly responsible for a large percentage of pavement failures and deterioration. Sufficient drainage for collection and disposal of surface runoff and excess ground water is vital to the stability and serviceability of pavement foundations. A periodic and complete inspection of drainage systems should be conducted by trained personnel and defective conditions of surface and subsurface

drainage systems should be recorded and corrected. Runway and taxiway edge drains and catch basins should be inspected at intervals (i.e., spring, summer, fall, and winter seasons of the year) and monitored following unusually heavy rainfall. The personnel making the inspection should look for distress signals which may indicate impending problems. These distress signals include:

a. Ponding of water in undesirable areas,

b. Buildup of soil at pavement edge preventing runoff,

c. Eroded ditches and spill basins,

d. Broken or displaced inlet grates or manhole covers,

e. Clogged or silted inlet grates or manhole covers,

f. Broken or deformed pipes,

g. Backfill settlement over pipes,

h. Erosion around inlets, and

i. Generally poor shoulder shaping and random erosion.

CHAPTER 5. MATERIALS AND EQUIPMENT

18. GENERAL. Normal day-to-day pavement maintenance requires only handtools, but certain specialized equipment may sometimes be needed. Routing-out of joints in concrete pavements is best accomplished by hand-operated, motor-driven machines especially designed for that purpose. Expedient plow-type devices have also been developed to aid in removing old joint material. Joint sealing can be accomplished by hand pouring from kettles with narrow spouts, but some sealing materials require pressure application and must be applied with specialized equipment.

a. If concrete slabs must be broken, the use of mechanical hammers is recommended. These hammers can also be used for drilling slabs.

b. Patching and spot sealing can be expedited by the use of trailer-type asphalt kettles. Those equipped with a powered hand-spray bar are valuable maintenance and repair items.

c. Compaction of patches can be accomplished with hand tampers, but better and more uniform results can be ensured if small vibrating compactors are employed. These vibrating compactors are easy to operate, are transportable in small vehicles, can work in very confined areas, and do an excellent job.

d. Large-scale work, for example seal coating of extensive areas, requires specialized equipment such as pressure distributors for bitumens, aggregate spreaders, and rollers. As a general rule, work of this type is performed by contractors or others organized for such large-scale activities.

e. Two to six men, trained in the various techniques of repairing and familiar with the tools available to them, can perform the routine maintenance required on the pavement surfaces. Work requiring more than such a crew would normally be considered as major repair and will require application of methods, materials, and equipment beyond the normal maintenance requirement.

19. MATERIALS. The materials listed below are commonly used for maintenance and repair of pavements.

a. Bituminous Concrete. Bituminous concrete is a blend of asphalt cement and well-graded, high-quality aggregates. The materials are mixed in a plant and placed and compacted while hot. Bituminous concrete is used for patching and overlay of airfield pavements.

b. Tack Coat. A tack coat is applied to an existing pavement to provide a bond with an overlying course such as a bituminous overlay. A tack coat is also used on the sides of an existing pavement that has been cut vertically prior to patching. Asphalt emulsion SS-1, SS-1h, CSS-1, and CSS-1h are commonly used for tack coats.

c. Prime Coat. A prime coat is applied to a nonbituminous base course for the following purposes:

(1) To waterproof the surface of the base,

(2) To plug capillary voids, and

(3) To promote adhesion between the base and the surface course.

Materials used as a prime coat include SS-1, SS-1h, CSS-1, and RC-70.

d. Fog Seal. A fog seal is a light application of emulsified asphalt for the purpose or rejuvinating the surface of a bituminous pavement. Asphalt emulsions are used as fog seals.

e. Aggregate Seal. Aggregate seals consist of sprayed asphalts which are immediately covered with aggregate and rolled and are used to seal the surface of weathered pavements.

f. Slurry Seal. A slurry seal is a mixture of a slow-setting asphalt emulsion, fine aggregate, mineral filler, and water. The mixture is prepared in the form of a slurry and applied in a film approximately 1/8 inch (3 mm) thick. Slurry seals are used to seal small cracks, to correct surface conditions, and to improve the skid resistance of pavement surfaces.

g. Sealing Material. Material for sealing cracks should meet ASTM standards for the type of pavement and service to which the pavement is to be subjected. ASTM D 3405, Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavements, is satisfactory for bituminous concrete and portland cement concrete pavements. ASTM D 3581, Joint Sealants, Hot-Poured, Jet-Fuel Resistant Type, For Portland Cement Concrete and Tar-Concrete Pavements, is satisfactory for areas subject to fuel spillage.

h. Concrete. Concrete is a blend of portland cement, fine and coarse aggregate, and water, with or without additives. Concrete is used to repair a distressed portland cement concrete pavement so that it may be used at its original designed capacity.

i. Joint Sealant. Material for sealing joints in portland cement concrete pavement is usually a hot or cold applied compound, meeting the following standards:

(1) ASTM D 1854, Jet Fuel-Resistant Concrete Joint Sealer, Hot-Poured Elastic Type.

(2) ASTM D 3406, Joint Sealants, Hot-Poured, Elastomeric Type for Portland Cement Concrete Pavements.

(3) ASTM D 3569, Joint Sealant, Hot-Poured, Elastomeric, Jet-Fuel Resistant Type for Portland Cement Concrete Pavements.

(4) Federal Specification SS-S-200, Sealing Compounds, Two Component, Elastomeric, Polymer Type, Jet-Fuel Resistant, Cold Applied.

j. Epoxy Grouts and Concretes. There are many types of epoxy resins; the type to be used depends on the application being considered. Under normal conditions, mixed resins may be workable up to one hour after mixing. Repairs with epoxy materials are costly and their use should be limited to small areas and application by experienced personnel.

20. EQUIPMENT. There are many different types and models of equipment that can be used for pavement maintenance. The equipment types listed below are commonly used by the regular maintenance crew:

a. Pavement Removal.

(1) Power Saws. Pavement power saws are usually one-man-operated, dolly-mounted units that have an abrasive circular blade. These saws are capable of cutting a straight line through asphalt or concrete pavements and leaving vertical sides.

(2) Cutting Disks. Cutting disks are circular, heavy-duty steel plates with a sharpened edge. The disk is usually attached to a motor grader or some other piece of equipment capable of pushing the disk through the pavement. The cutting disk is much faster than sawing and is recommended where larger areas must be removed; however, it is limited to approximately 3 inches (75 mm) in cutting depth.

(3) Jack Hammers. Jack hammers with a chisel head are commonly used for cutting pavement surfaces.

(4) Pavement Grinders. Pavement grinders are usually one-man-operated, dolly-mounted units that have an abrasive cylindrical head 4 inches (100 mm) or more wide. The grinder may outline an area to be patched by cutting a vertical-faced trench into the existing pavement that will anchor the feathered edge of a patch.

(5) Hand Tools. Hand tools can be used to make vertical cuts through pavements, as well as to break up deteriorated pavement. Chisels, sledgehammers, shovels, pry bars, and picks are examples of this type of equipment.

(6) Front End Loaders. Front end loaders are useful in loading trucks when removing old pavement.

(7) Dump Trucks. Dump trucks are used to haul removed pavement and repair materials.

b. Maintenance Equipment.

(1) Asphalt Kettle. Asphalt kettles are usually small tractor mounted units that have a capacity of heating and storing 40 to 500 gallons (.15 m^3 to 2.0 m^3) of bituminous material. A pump is used to force the liquid material through spray nozzles located on a hand-held hose. These units are used for priming and tacking on small jobs and for crack or surface sealing of bituminous surfaces.

(2) Aggregate Spreaders. Aggregate spreaders can be either truck-mounted or separate units. They are used to evenly place a controlled amount of sand or aggregate on an area.

(3) Handtools. Rakes, lutes, and other such handtools are used to move and level material after it has been placed in a patch area.

c. Compaction Equipment.

(1) Vibratory Plate Compactors. Vibratory plate compactors are hand-operated units used to compact granular base or bituminous plant-mix materials.

(2) Vibratory Steel-Wheel Rollers. Vibratory steel-wheel rollers are hand operated and are used to compact material, including bituminous concrete in patchwork areas.

d. Crack and Joint Sealing Equipment.

(1) Joint Plow. A joint plow is used to remove old sealer from joints. This is usually a specially made tool attached to a farm tractor.

(2) Joint Router. A joint router is used to clear existing cracks or joints to be resealed. A router is usually a self-powered machine operating a rotary cutter or revoling cutting tool. A rotary routing tool with a V-shaped end can be used for cleaning out random cracks.

(3) Power Brush. A power-driven wire brush may be used to clean joints after all of the old joint sealer has been removed.

(4) Air Compressor and Sand Blasting. In some instances, sand blasting may be used for final removal of joint sealant. Joints and cracks should be blown out with compressed air immediately prior to application of new sealer.

(5) Pavement Sweeper. A pavement sweeper can be used for cleaning the pavement surface and removing excess aggregate. Cleaning operations are necessary in preparation for seal coating and crack filling.

(6) Heating Kettle. A heating kettle is a mobile indirect-fired double boiler used to melt hot applied joint sealing material. It is equipped with a means to agitate and circulate the sealer to ensure uniform heating and melting of the entire charge in the kettle. The sealers may be applied to joints with a pressure base attached directly to a pump unit on the kettle.

(7) Pouring Pot. A pouring pot is hand carried and is used to pour hot sealing materials into a previously prepared crack or joint.

CHAPTER 6. METHODS OF REPAIR

21. GENERAL.

a. Visible evidence of excessive stress levels in pavement systems may include cracks, holes, depressions, and other types of pavement distresses. The formation of distresses in airport pavements may severely affect the structural integrity, ride quality, and safety of airport pavements. To alleviate the effects of distresses and to improve the airport pavement serviceability, an effective and timely maintenance program and adequate repair procedures should be adopted.

b. In all cases of pavement distress, the first step in rehabilitating a pavement should be to determine the causes of distress. Then, the proper procedures for repair, which will not only correct the damage but will also prevent or retard its further occurrence, may be applied. Pavement repairs should be made as quickly as possible after the need for them is assessed so that continued and safe aircraft operations can be ensured. While deterioration of the pavements due to traffic and adverse weather conditions cannot be completely prevented, maintenance and repair programs can reduce this deterioration to a minimum level.

c. Repair measures to prevent further pavement damage may be limited by weather conditions. For example, rehabilitation by crack filling is more effective in cool and dry weather conditions, whereas pothole patches adhere best during warm and dry days. In addition, seal coats and other surface treatments require warm and dry weather for best results. This does not mean that resurfacing work cannot be performed under cold and damp conditions. Rather, these repairs require much greater care when made during such periods. Another important consideration is the timeliness of the repair. Repairs should be made at early stages of distress, even when they may be considered minor. A delay in repairing pavements may allow minor distresses to progress into major failures.

22. REPAIR METHODS FOR PORTLAND CEMENT CONCRETE PAVEMENTS.

a. Crack Repair and Sealing. Sealing should be considered only for cracks that are open wide enough to permit the entry of joint sealant or mechanical routing tools. Tightly closed cracks are probably nonstructural cracks that occurred soon after construction.

(1) Longitudinal, Transverse, and Diagonal Cracks.

(i) Route out. A groove about 3/8 inch wide (10 mm) and 3/4 inch deep (20 mm) should be made along the crack.

(ii) Clean out with compressed air. The crack must be free of dirt, dust, and other material that might prevent bonding of the sealant.

(iii) Fill the crack with sealant materials.

(2) Corner Cracks. The following procedure is used to repair corner cracks accompanied by loss of subgrade support. For low severity cracks, the procedure for crack sealing should be used.

(i) Make a vertical cut with a concrete saw and break out the broken corner.

(ii) Add subbase material, if necessary, and compact.

(iii) Clean the vertical faces of the remainder of the slab with a high-pressure water jet or compressed air.

(iv) Coat the faces of the adjacent slabs with a bond-breaking medium to prevent bonding of the new concrete.

(v) Maintain the existing joint by using temporary inserts or by sawing the required kerf.

(vi) Coat the clean surface with sand-cement grout or epoxy grout.

(vii) Place the portland cement concrete in the patch area while the grout is still tacky.

(viii) After the concrete has cured, remove the joint inserts or saw a kerf.

(ix) Seal joints.

(3) "D" Cracking. The repair of this type of distress usually requires that the complete slab be repaired since normally "D" cracking will show up again adjacent to the repaired areas.

(4) Joint Seal Damage. The sequence of operations for preparing joints for resealing is as follows:

(i) Use joint router to remove the joint sealing material to a depth of at least 1 inch (25 mm).

(ii) Reface the side of the joint to expose sound concrete that is free of old sealer. This may be accomplished with a power saw.

(iii) Use a power wire brush to remove debris.

(iv) Blow out the joints with compressed air.

(v) Seal joints with hot or cold compounds. Hot poured sealants should be injected into the joint through nozzles shaped to penetrate into the joint and fill the reservoir from the bottom. On small jobs, hand-pouring pots may be used.

b. Disintegration. If not corrected in its early stages, disintegration can progress until the pavement requires complete rebuilding.

(1) Scaling, Map Cracking, and Crazing.

(i) Make a vertical cut with a concrete saw about 1 to 2 inches (25 to 50mm) deep at the perimeter of the scaled area.

(ii) Break out the broken concrete with pneumatic tools until sound concrete is exposed.

(iii) Clean the area with compressed air or high-pressure water jet.

(iv) Coat the surface of the old concrete with a thin coat of sand-cement grout. Dampen surface with water before applying the grout.

(v) Place the portland cement concrete while the grout is still tacky.

(vi) If the patch crosses or abuts a working joint, the joint must be continued through the patch.

(2) Joint Spalling and Corner Spalling. The procedure for repair of spalls is as follows:

(i) Make a vertical cut with a concrete saw 1 inch (25 mm) in depth and approximately 2 inches (50 mm) back of the spalled area.

(ii) Break out the unsound concrete with air hammers or pneumatic drills and blow out the area with compressed air.

(iii) Pressure rinse the area to be repaired.

(iv) Treat the surface with a grout mixture to ensure a good bond between the existing pavement and the new concrete. Apply the grout immediately before placing the patch mixture and spread with a stiff broom or brush to a depth of 1/16 inch (2 mm).

(v) Place a thin strip of wood or metal coated with bond-breaking material in the joint groove and tamp the new mixture into the old surface. The mix should be air-entrained and designed to produce a no slump concrete which will require tamping to place in the patch.

(vi) After edging of the patch has been completed, it should be finished to a texture matching the adjacent area.

(vii) After curing for a minimum of 3 days, the open joint shall be filled with joint material prior to opening to traffic.

(3) Crack Spalling. The procedure is the same as for joint spalling except for the joint repair.

(4) Blowups. Blowups may be repaired using the following procedures:

(i) Make a vertical cut with a concrete saw approximately 6 inches (15 cm) outside of each end of the broken area.

(ii) Break out the concrete with pneumatic tools and remove concrete down to the subbase/subgrade material.

(iii) Add subbase material, if necessary, and compact.

(iv) In reinforced pavement construction, joint techniques should be used to tie the new concrete to the old reinforced material. Any replacement joints should be doweled and built to joint specifications. For simplicity of construction, all tiebars, dowels, and reinforcement may be omitted from small interior pavement patches on well-compacted subgrades.

(v) Dampen the subgrade and the edges of the old concrete.

(vi) Place concrete on the area to be patched.

(vii) Use ready-mixed concrete if it is satisfactory and can be obtained economically. It may be desirable to use a mixture providing high early strength in order to permit the earliest possible use.

(viii) Finish the concrete so that the surface texture approximates that of the existing pavement.

(ix) Immediately after completion of finishing operations, the surface should be properly cured. Either a moist cure or a curing compound may be used.

(5) Shattered Slab. Follow the same procedure for blowup repairs except that unstable subgrade materials should be removed to a minimum depth of 12 inches (30 cm) and replaced with select material. Poor drainage conditions should be corrected by the installation of drains for removal of excess water.

c. Distortion. If not too extensive, some forms of distortion such as from settlement can be remedied by raising the slab to the original grade.

(1) Pumping and Settlement. Slabjacking procedures may be used to correct this type of distress. In slabjacking, a grout is pumped under pressure through holes cored in the pavement into the void under the pavement. This creates an upward pressure on the bottom of the slab in the area around the void. The upward pressure lessens as the distance from the grout hole increases. Thus, it is possible to raise one corner of a slab without raising the entire slab. Because of special equipment and experience required, slabjacking is usually best done by specialty contractors.

d. Skid Resistance. Treatment includes resurfacing, grooving, milling, and surface cleaning.

(1) Polished Aggregate. Since polished aggregate distress normally occurs over an extensive area, grooving or milling of the entire pavement surface should be considered. Concrete or bituminous resurfacing may also be used to correct this condition.

(2) Contaminants. Rubber deposits may be removed by use of high-pressure water or biodegradable chemicals.

23. BITUMINOUS PATCHING. Broken concrete areas can be patched with bituminous concrete as an interim measure. Repair for corner cracks, diagonal cracks, blowups, and spalls can be made using the following procedure:

a. Make a vertical cut with a concrete saw completely through the slab.

b. Break out the concrete with pneumatic tools and remove broken concrete down to the subbase/subgrade material.

c. Add subbase/subgrade material if required and compact.

d. Apply prime coat to subbase material.

e. Apply tack coat to the sides of the slab.

f. Place bituminous concrete in layers not exceeding 3 inches (75 mm).

g. Compact each layer with a vibratory-plate compactor, roller, or mechanical rammers.

Normal traffic may be permitted on bituminous patches immediately after completion of the patch.

24. REPAIR METHODS FOR BITUMINOUS CONCRETE PAVEMENTS.

a. Crack Sealing. Cracking takes many forms. In some cases, simple crack filling may be the proper corrective action. In others, complete removal of the cracked area and the installation of drainage may be necessary.

(1) Longitudinal, Transverse, Reflection, and Block Cracking. Narrow cracks (less than 1/8 inch (3 mm)) are too small to seal effectively. In areas where narrow cracks are present, a seal coat, slurry seal, or fog coat may be applied. Wide cracks (greater than 1/8 inch (3 mm)) should be sealed using the following procedure:

(i) Clean out crack with compressed air to remove all loose particles.

(ii) Fill cracks with a prepared joint sealer.

(2) Alligator Cracking. Permanent repairs by patching may be carried out as follows:

(i) Remove the surface and base as deep as necessary to reach a firm foundation. In some cases, a portion of the subgrade may also have to be removed. A power saw should be used to make a vertical cut through the pavement. The cut should be square or rectangular.

(ii) Replace base material with material equal to that removed. Compact each layer placed.

(iii) Apply prime coat to the base material and vertical faces of existing pavement.

(iv) Place bituminous concrete and compact.

(v) Temporary repairs can be made by applying a seal coat to the affected area.

(3) Slippage Cracks. One repair method commonly used for slippage cracks involves removing the affected area and patching with plant-mixed asphalt material. The specific steps are given below:

(i) Remove the slipping area and at least 1 foot (300 mm) into the surrounding pavement. Make the cut faces straight and vertical. A power pavement saw makes a fast and neat cut.

(ii) Clean the surface of the exposed underlying layer with brooms and compressed air.

(iii) Apply a light tack coat.

(iv) Place enough hot plant-mixed asphalt material in the cutout area to make the compacted surface the same grade as that of the surrounding pavement.

b. Disintegration. If not stopped in its early stages, disintegration can progress until the pavement needs complete rebuilding.

(1) Raveling. Further deterioration from raveling may be prevented by using the following procedures:

(i) Sweep the surface free of all dirt and loose aggreate material.

(ii) Apply a fog seal diluted with equal parts of water.

(iii) Close to traffic until the seal has cured.

(iv) Apply a surface treatment such as an aggregate seal coat.

(v) A pavement planing machine, such as a heater-plane, may be used to soften the surface of the pavement and then applying a seal coat or bituminous concrete overlay.

c. Distortion. Repair techniques range from leveling the surface by filling with new material to complete removal of the affected area and replacing with new material.

(1) Rutting. Repair procedures are as follows:

(i) Determine the severity of the rutting with a straightedge or stringline. Outline the areas to be filled.

(ii) Apply a light tack coat of asphalt emulsion diluted with equal parts of water.

(iii) Spread dense-graded asphalt concrete with a paver and compact. Be sure that the material is feathered at the edges.

(iv) Place a thin overlay of bituminous concrete over the entire area.

(2) Corrugation and Shoving. The repair procedure for this type of distress is the same as for patch repair of alligator cracking.

(3) Depressions. Repair procedures are as follows:

(i) Determine the limits of the depression with a straightedge or stringline. Outline it on the pavement surface with a marking crayon.

(ii) If grinding equipment is available, grind down the area to provide a vertical face around the edge. If this equipment is not available, this step may be omitted.

(iii) Thoroughly clean the entire area to at least 1 foot (25 cm) beyond the marked limits.

(iv) Apply a light tack coat of asphalt emulsion diluted with equal parts of water to the cleaned area.

(v) Allow the tack coat to cure.

(vi) Spread enough bituminous concrete in the depression to bring it to the original grade when compacted. The correct way to repair a deep depression is to begin in the deepest part of the depression and place a thin layer, the surface of which, when compacted, will be parallel to the original pavement surface. Successive layers are placed in the same manner.

(vii) If the pavement was not ground down, the edges of the patch should be feather-edged by careful raking and manipulation of the material. However, in raking, care should be taken to avoid segregation of the coarse and fine particles of the mixture.

(viii) Thoroughly compact the patch with a vibratory-plate compactor, roller, or hand tamps.

(4) Swelling. The repair procedure is the same as for patch repair of alligator cracking.

d. Skid Resistance. Treatment includes removal of excess asphalt, resurfacing, grooving to improve surface drainage, and removal of rubber deposits.

(1) Bleeding. Repair procedures using hot sand or aggregate are as follows:

(i) Apply slag screenings, sand, or rock screenings to the affected area. The aggregate should be heated to at least 300°F (150°C) and spread at the rate of 10 to 15 pounds per square yard (4 to 9 kg per square meter).

(ii) Immediately after spreading, roll with a rubber-tired roller.

(iii) When the aggregate has cooled, broom off loose particles.

(iv) Repeat the process, if necessary.

(v) A pavement planing machine, such as a heater-planer, may be used to remove the excess asphalt; specifically:

(A) Remove the asphalt film with a heater-planer.

(B) Leave the surface as planed; or

(C) Apply either a plant-mixed surface treatment or a seal coat.

(2) Polished Aggregate. One means of correcting this condition is to cover the surface with an aggregate seal coat. Grooving or milling the pavement surface may also be used.

(3) Fuel Spillage. Permanent repairs for areas subjected to continuous fuel spillage consist of removal of the damaged pavement and replacement with portland cement concrete or an overlay with a tar emulsion seal coat.

(4) Contaminants. Rubber deposits may be removed by use of high-pressure water or biodegradable chemicals.

25. ADDITIONAL REPAIR METHODS. Detailed procedures for bituminous concrete repairs are contained in "MS-16, Asphalt in Pavement Maintenance," published by The Asphalt Institute. Detailed procedures for portland cement concrete pavement repairs are contained in the following publications available from the Portland Cement Association: "Maintenance of Joints and Cracks in Concrete Pavements," "Patching Concrete Pavements," and "Cement Grout Subsealing and Slab-Jacking of Concrete Pavement." (See appendix C.) A summary of maintenance and repair procedures for rigid and flexible pavement is contained in table 1.

Table 1. Maintenance and repair of pavement surfaces.

PROBLEM	PROBABLE CAUSE	CURE
Crack and joint sealer missing or not bonded to slabs	Faces of joints (cracks) not clean when filled; incorrect application temperature of sealer; wrong kind of seal material; improper joint width.	Remove old material if extensive areas affected; clean joints and cracks; reseal properly.
Random cracking	Uncontrolled shrinkage (improper joint spacing); overstressed slabs; slab support lost; subgrade settlement; bitumen too hard or overheated in mix.	Seal newly formed cracks; replace subbase to establish support; if pavement being overloaded, probably will require overlay.
Surface scaling or breakup	<u>In PCC</u> - Overworked finishing operation; inadequate curing. <u>In Flexible Pavement</u> - Overheated binder; poor aggregate gradation; insufficient binder; incorrect binder or aggregate; fuel spillage, stripping.	<u>In PCC</u> - Remove and replace panel; resurface with thin bonded concrete; resurface area with a bituminous concrete. <u>In Flexible Pavement</u> - Apply seal coat; overlay.
Joint (1) faulting or (2) spalling	(1) Variable support for unbonded slabs; loss of load transfer capability; (2) Incompressible matter in joint spaces; excessive joint finishing.	(1) Remove problem slab; replace subbase; replace slab (tie to existing pavement); (2) Clean joint; refill with bituminous-sand mix; reseal.
Pumping	Saturated pavement foundation; lack of subbase.	Prevent entrance of water (correct the drainage problem); pump slurry under slabs to reseal; replace slabs and slab foundation.

Table 1. Maintenance and repair of pavement surfaces (continued).

PROBLEM	PROBABLE CAUSE	CURE
Surface irregularities: Rutting, Washboarding, Birdbaths, Undulations	In PCC - Poor placing control; broken slabs; poor finishing. In Flexible Pavement - Nonuniform settlement from inadequate compaction of pavement components or fill; unstable mix (poor aggregate gradation, too rich, etc.); poor laying control.	In PCC - Patch local areas, or overlay if widespread. In Flexible Pavement - Patch local areas; apply leveling course; roto-mill.
Bleeding of bituminous binder	Too much binder in mix (overrich mix).	Scrape off excess material; blot with sand. Note: Bleeding is usually an indication that other surface deformities (rutting, washboarding, etc.) will occur.
Potholes	Water entering pavement structures; segregation in base course material.	Remove and replace base (and subbase if required); replace surface and seal.
Oxidation of bituminous binder	Lack of timely seal coat; binder overheated in mixing; wrong grade of asphalt for climate.	Apply seal coat; heater planer; resurface.
Map cracking, Crazing, Alligator cracking	In PCC - Excessive surface finishing. In Flexible Pavement - Overload; oxidized binder; under-designed surface course (too thin).	In PCC - If surface deforms or breaks, resurface. In Flexible Pavement - Overlay; apply seal coat.
Popouts at joints	Dowels misaligned.	Fill popout hole with bituminous concrete or bituminous sand mix (if recurring, may require replacement of slabs). assembly).

Table 1. Maintenance and repair of pavement surfaces (continued).

PROBLEM	PROBABLE CAUSE	CURE
Slab "blowup"	Incompressible material in joints preventing slab from expanding.	Replace slab in blownup area; clean and reseal joints.
Slipperiness	In PCC - Improper finish (too smooth); type of curing membrane; excessive curing membrane; polished aggregate, rubber deposits. In Flexible Pavement - Overrich mix; poorly designed mix; polished aggregate; improperly applied seal coat; wrong kind of seal coat; rubber deposits.	In PCC - If finish too smooth, resurfacing required to provide texture; wire broom to remove curing membrane; grooving; remove rubber. In Flexible Pavement - Apply textured seal coat; grooving; remove rubber.

APPENDIX A: CONDITION SURVEY PROCEDURE

GENERAL

This appendix gives the detailed procedure for performing a pavement condition survey at civil airports. The procedure is presently limited to flexible pavements (all pavements with conventional bituminous concrete surfaces) and jointed rigid pavements (jointed nonreinforced concrete pavements with joint spacing not exceeding 25 ft). Specific objectives for the condition survey are:

- a. To determine present condition of the pavement in terms of apparent structural integrity and operational surface condition.
- b. To provide FAA with a common index for comparing the condition and performance of pavements at all airports and also provide a rational basis for justification of pavement rehabilitation projects.
- c. To provide feedback on pavement performance for validation and improvement of current pavement design, evaluation, and maintenance procedures.

The airport pavement condition survey and the determination of the PCI are the primary means of obtaining and recording vital airport pavement performance data. The condition survey for both rigid and flexible pavement facilities consists principally of a visual inspection of the pavement surfaces for signs of pavement distress resulting from the influence of aircraft traffic and environment.

BASIC AIRPORT INFORMATION

A considerable amount of basic airport data is incorporated into the condition survey report. Most of this information is contained in construction and maintenance records and in previous condition survey reports. To facilitate report preparation, the basic data should be accumulated and maintained by the airport engineer. The following items should be compiled for subsequent use during the condition survey:

- a. Design/construction/maintenance history. The history of maintenance, repair, and reconstruction from original construction of the airport pavement system to the present should be maintained. These data should reflect airport paving projects and airport change projects accomplished either in-house or by a contractor.

b. Traffic history. Air carrier, commuter, cargo, and military aircraft traffic records, including aircraft type, typical gross loads, and frequency of operation.

c. Climatological data. Annual temperature ranges and precipitation data should be obtained from the weather office nearest the airport.

d. Airport layout. Plans and cross sections of all major airport components, including subsurface drainage systems. These should be updated to reflect new construction upon completion of the project.

e. Frost action. If applicable, records of pavement behavior during freezing periods and subsequent thaws should be recorded.

f. Photographs. Photographs depicting both general and specific airport conditions should be taken.

g. Pavement condition survey reports. All previous pavement condition survey reports should be maintained to be referenced in the current report.

A series of data summary sheets has been devised and is presented in Figures A-1 through A-4. These summary sheets should be helpful to the personnel involved in obtaining and maintaining the necessary information. Narrative information pertaining to unusual problems, solutions, or attempted solutions to these problems should be included. This information would be beneficial in determining research needs as well as in providing a means of distributing information.

OUTLINE OF BASIC CONDITION RATING PROCEDURE

The steps for performing the condition survey and determining the PCI are described below and in Figure A-5:

a. Station or mark off the airport pavements in 100-ft increments. This is done semipermanently to assure ease of proper positioning for the condition survey. The overall airport pavements must first be divided into features based on the pavements design, construction history, and traffic area. A designated pavement feature, therefore, has consistent structural thickness and materials, was constructed at the same time, and is located in one airport facility, i.e., runway, taxiway, etc. After initially designating the features on the airport, make a preliminary survey. This survey shall entail a brief but complete visual survey of all the airport pavements. By observing distress in an individual feature, it may be determined whether there are varying degrees of distress in different areas. In such cases, the feature should be subdivided into two or more features.

b. The pavement feature is divided into sample units. A sample unit for jointed rigid pavement is approximately 20 slabs; a sample unit for flexible pavement is an area of approximately 5000 sq ft.

c. The sample units are inspected, and distress types and their severity levels and densities are recorded. Appendix B provides a comprehensive guide for identification of the different distress types and their severity levels. The criteria in Appendix B must be used in identifying and recording the distress types and severity levels in order to obtain an accurate PCI.

d. For each distress type, density, and severity level within a sample unit, a deduct value is determined from the appropriate curve.

e. The total deduct value (TDV) for each sample unit is determined by adding all deduct values for each distress condition observed.

f. A corrected deduct value (CDV) is determined using procedures in the appropriate section for jointed rigid or flexible pavements.

g. The PCI for each sample unit inspected is calculated as follows:

$$PCI = 100 - CDV$$

If the CDV for a sample unit is less than the highest individual distress deduct value, the highest value should be used in lieu of the CDV in the above equation.

h. The PCI of the entire feature is the average of the PCI's from all sample units inspected.

i. The feature's pavement condition rating is determined from a figure that presents verbal descriptions of a pavement condition as a function of PCI value.

SAMPLING TECHNIQUES

Inspection of an entire feature may require considerable effort, especially if the feature is very large. This may be particularly true for flexible pavements containing much distress. Because of the time and effort involved, frequent surveys of the entire feature may be beyond available manpower, funds, and time. A sampling plan has, therefore, been developed so that an adequate estimate of the PCI can be determined by inspecting a portion of the sample units within a feature. Use of the statistical sampling plan described here will considerably reduce the time required to inspect a feature without significant loss of accuracy. However, this statistical sampling plan is optional, and inspection of the entire feature may be desirable. The airport engineer should specify whether statistical sampling may be used. The condition survey proceeds as follows:

a. Determination of pavement feature. The first step in the condition survey is the designation of pavement features. Each facility such as a runway, taxiway, etc., is divided into segments or features that are definable in terms of (1) the same design, (2) the same construction history, (3) the same traffic area, and (4) generally the same overall condition. General features can be determined from pavement design and construction records and can be further subdivided as deemed necessary based on a preliminary survey. It is important that all pavement in a given feature be such that it can be considered uniform. As an example, the center part of some runways in the traffic lanes should be separate features from the shoulder portion outside the traffic lanes.

b. Selection of sample units to be inspected. The minimum number of sample units that must be surveyed to obtain an adequate estimate of the PCI of a feature is selected from Figure A-6. Once the number of sample units η has been determined from Figure A-6, the spacing interval of the units is computed from

$$i = \frac{N}{\eta}$$

where

i = spacing interval of units to be sampled
N = total number of sample units in the feature
η = number of sample units to be inspected

All the sample numbers within a feature are numbered and those that are multiples of the interval i are selected for inspection. The first sample unit to be inspected should be selected at random between 1 and i. Sample unit size should be 5000 sq ft (generally 50 by 100 ft) for flexible pavement and 20 adjacent slabs for rigid pavement. Figures A-7 and A-8 illustrate the division of a jointed rigid pavement and flexible pavement feature, respectively, into sample units.

Each sample unit is numbered so it can be relocated for future inspections, maintenance needs, or statistical sample purposes. Each of the selected sample units must be inspected and its PCI determined. The mean PCI of a pavement feature is determined by averaging the PCI of each sample unit inspected within the feature. When it is desirable to inspect a sample unit that is in addition to those selected by the above procedure, then one or more additional sample units may be inspected and the mean PCI of the feature computed from:

$$PCI_f = \frac{(N - A)}{N} \overline{PCI_1} + \frac{A}{N} \overline{PCI_2}$$

where

PCI_f = mean PCI of feature

N = total number of sample units in feature

A = number of additional sample units

$\overline{PCI_1}$ = mean of PCI for n number of statistically selected units

$\overline{PCI_2}$ = mean PCI for all additional sample units

It is necessary that each sample unit be identified adequately so that it can be relocated for additional inspections to verify distress data or for comparison with future inspections. Based on significant variation of sample unit PCI along a feature and/or significant variation in distress types among sample units, one feature should be divided into two or more features for future inspections and maintenance purposes.

DETAIL SURVEY PROCEDURE FOR RIGID PAVEMENT

Each sample unit, or those selected by the statistical sampling procedure, in the feature is inspected. The actual inspection is performed by walking over each slab of the sample unit being surveyed and recording distress existing in the slab on the jointed rigid pavement survey data sheet (Figure A-9). One data sheet is used for each sample unit. A sketch is made of the sample unit, using the dots as joint intersections. The appropriate number code for each distress found in the slab is placed in the square representing the slab. The letters L (low), M (medium), or H (high) are included along with the distress number code to indicate the severity level of the distress. For example, 15L indicates that low severity corner spalling exists in the slab.

Refer to Appendix B for aid in identification of distresses and their severity levels. Follow these guidelines very closely.

Space is provided on the jointed rigid pavement survey data sheet for summarizing the distresses and computing the PCI for the sample unit. Summarize the distress type numbers and their severity levels and the number of slabs in the sample unit containing each type and level. Calculate the percentage of the total number of slabs in the sample unit containing each distress type and severity level. Using Figures A-10 through A-24, determine the deduct value for each distress type and severity level. Sum the deduct values to obtain the deduct total.

Noting how many individual deduct values are greater than 5, consult Figure A-25 to obtain the CDV. The PCI is then calculated and the rating (from Figure A-26) is entered on the jointed rigid pavement survey data sheet (Figure A-9). If the CDV for a sample unit is less than the highest individual distress deduct value, the highest value should be used in determining the PCI.

The PCI's for all sample units are compiled into a feature summary, as shown in Figure A-27. The overall condition rating of the feature is determined by using the mean PCI and Figure A-26.

DETAILED PROCEDURE FOR FLEXIBLE PAVEMENT

Each sample unit, or those selected by the sampling procedure, in the feature is inspected. The distress inspection is conducted by walking over the sample unit, measuring the distress type and severity according to Appendix B, and recording the data on the flexible pavement survey data sheet (Figure A-28). One data sheet is used for each sample unit. A hand odometer is very helpful for measuring distress. A 10-ft straightedge and a 12-in. scale must be available for measuring the depths of ruts or depressions. Each column on the data sheet is used to represent a distress type, and the amount and severity of each distress located are listed in the column. For example, distress No. 5 (depression) is recorded as 6 × 4L, which indicates that the depression is 6 by 4 ft and of low severity. Distress type No. 8 (longitudinal and transverse cracking) is measured in linear feet, thus 10L indicates 10 ft of light cracking. This format is very convenient for recording data in the field.

Each distress type and severity level are summed either in square feet or linear feet, depending on the type of distress. The total units, either in square feet or linear feet, for each distress type and severity level are divided by the area of the sample unit to obtain the percent density. Using Figures A-29 through A-44, determine the deduct value for each distress type and severity level. Sum the deduct values to obtain the deduct total.

Noting how many individual deduct values are greater than 5, use Figure A-45 to obtain the CDV. The PCI is then calculated, and the rating (from Figure A-26) is entered on the flexible pavement survey data sheet. If the CDV for a sample unit is less than the highest individual distress deduct value, the highest value should be used in determining the PCI.

The PCI's for each sample unit are compiled into a feature summary, as shown in Figure A-46. The mean PCI for the feature is determined by averaging the PCI's from each sample unit. The overall condition rating of the feature is determined by use of the mean PCI and Figure A-26.

REPORTING CONDITION SURVEY RESULTS

The format for reporting the findings of the airport condition survey may be informal, designed to preclude the necessity of extensive drafting and typing. The pavement distress data and PCI computations can be presented as directly obtained from the survey data sheets and computations. The basic airport data collected will primarily reflect changes in airport pavement systems that have occurred since the last condition survey report. Reports should be prepared by the airport engineer on a recurring cycle at intervals designed to reflect gradual changes in pavement surface conditions. Reports should include, but not be limited to, the following:

a. Design pavement structure data. A form, such as Figure A-1, to include the history of all airport pavements, from original construction to the most recent changes and additions.

b. Pavement structural evaluation summary. If available, a summary of the last structural evaluation data (see Figure A-2).

c. Pavement maintenance record. When, where, and what type of maintenance has been performed (see Figure A-3).

d. Aircraft traffic data survey. Types of aircraft, typical gross loads, and airport facilities most likely used by the aircraft; also, the frequency of operations (see Figure A-4).

e. Plans and cross sections.

(1) Airport layout plan. The airport layout plan should depict airport pavements existing at the time of the condition survey. All airport facilities should be delineated and identified.

(2) Condition rating. An airport layout plan keyed to indicate the narrative condition rating of each feature. The feature PCI's should be indicated, possibly in tabular form.

(3) Drainage. Existing problem areas should be identified. Surface and subsurface drainage should be shown in plan and profile for all areas near to and intersecting with airport pavements.

f. Narrative. A narrative consisting of a written account of the visual condition of each feature. The purposes of the narrative are:

(1) To briefly describe the general condition of the pavement facilities.

(2) To describe operational conditions and problems.

(3) To describe the condition of other airport facilities found near the load-bearing pavements such as runway shoulders and overrun areas.

g. Photographs. Photographs showing typical or specific pavement conditions. An aerial photograph, current within 3 years, is desirable.

__________ AIRPORT

DESIGN PAVEMENT STRUCTURE DATA REVISED: __________

FACILITY: __________ LOCATION, OR SECTION DESIGNATION FROM LAYOUT: __________

CONSTRUCTION DATE	DESIGNED BY	PAVEMENT SURFACE	BASE	SUBBASE	SUBGRADE
		TYPE/THICKNESS/STRENGTH	TYPE/THICKNESS/STRENGTH	TYPE/THICKNESS/STRENGTH	TYPE/STRENGTH

Figure A-1. Design pavement structure data

____________________ AIRPORT

PAVEMENT STRUCTURAL EVALUATION SUMMARY

FACILITY	LOCATION	DATE OF EVALUATION	TYPE OF EVALUATION	EVALUATED BY	ALLOWABLE LOAD (AIRCRAFT, LOAD, DEPARTURES)	THICKNESS AND TYPE OF OVERLAY RECOMMENDED

Figure A-2. Pavement structural evaluation summary

________________ AIRPORT

CHRONOLOGICAL PAVEMENT MAINTENANCE RECORD

FACILITY	LOCATION	DATE PERFORMED	PERFORMED BY	TYPE MAINTENANCE	REASON FOR MAINTENANCE

Figure A-3. Pavement maintenance record

____________ AIRPORT

TRAFFIC DATA SURVEY REVISED: ________

TYPE OF OPERATION	AIRCRAFT OPERATOR	TYPE AIRCRAFT	FACILITY MOST FREQUENTLY USED			TYPICAL GROSS WEIGHT	DEPARTURES PER DAY
			RUNWAY	TAXIWAY	APRON		
AIR CARRIER							
COMMUTER							
CARGO							
MILITARY							

Figure A-4. Traffic data survey

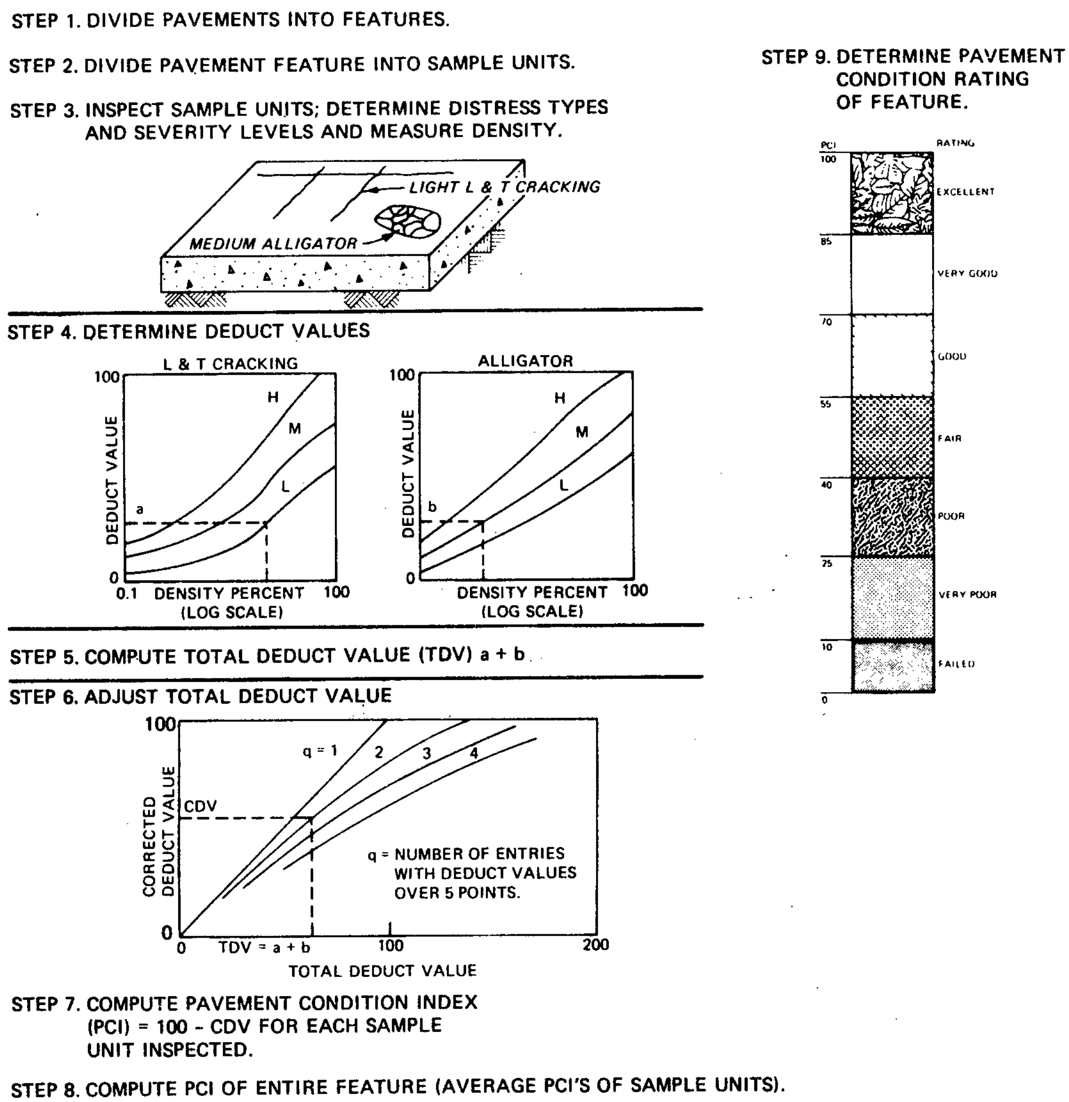


Figure A-5. Steps for determining PCI of a pavement feature

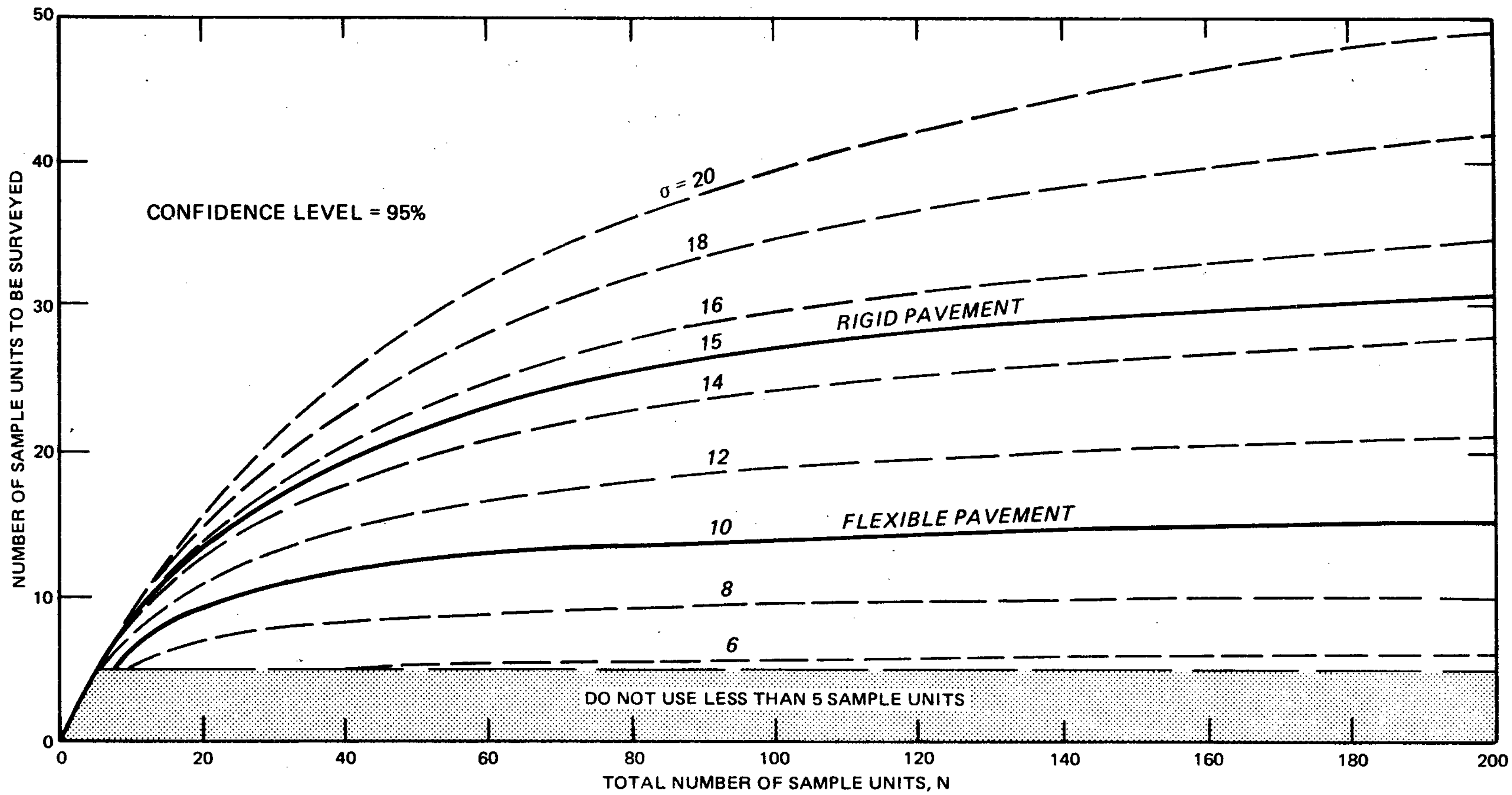


Figure A-6. Selection of minimum number of sample units

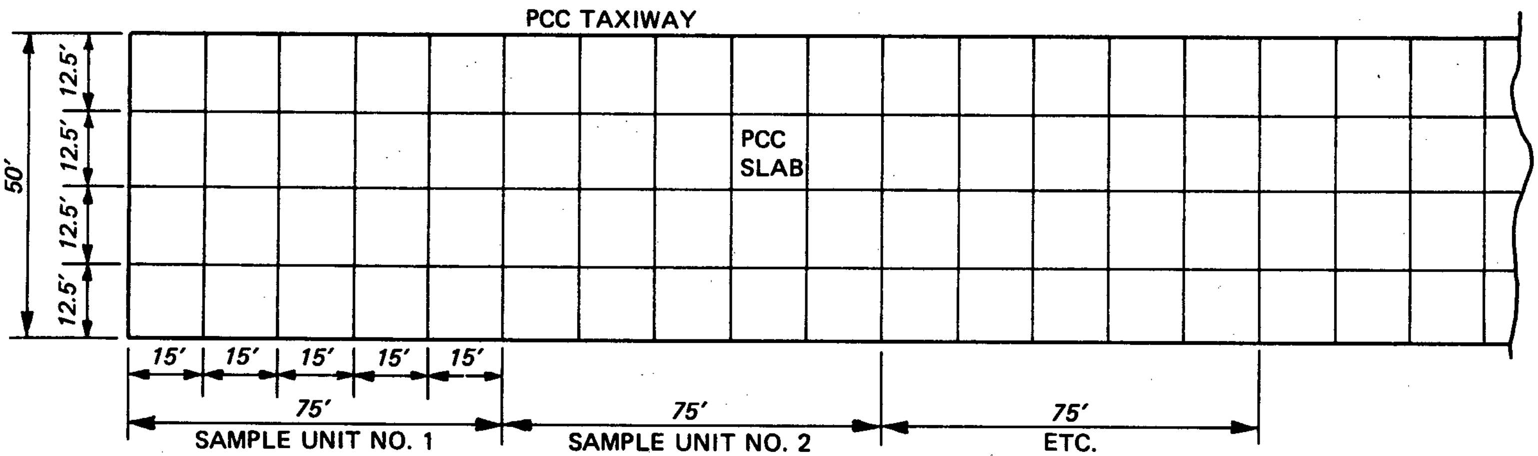


Figure A-7. Illustration of division of a jointed rigid pavement feature into sample units of 20 slabs

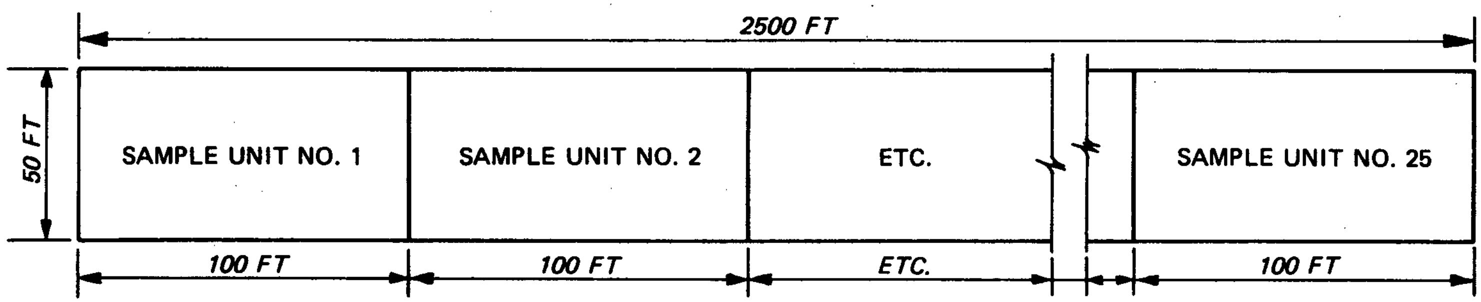
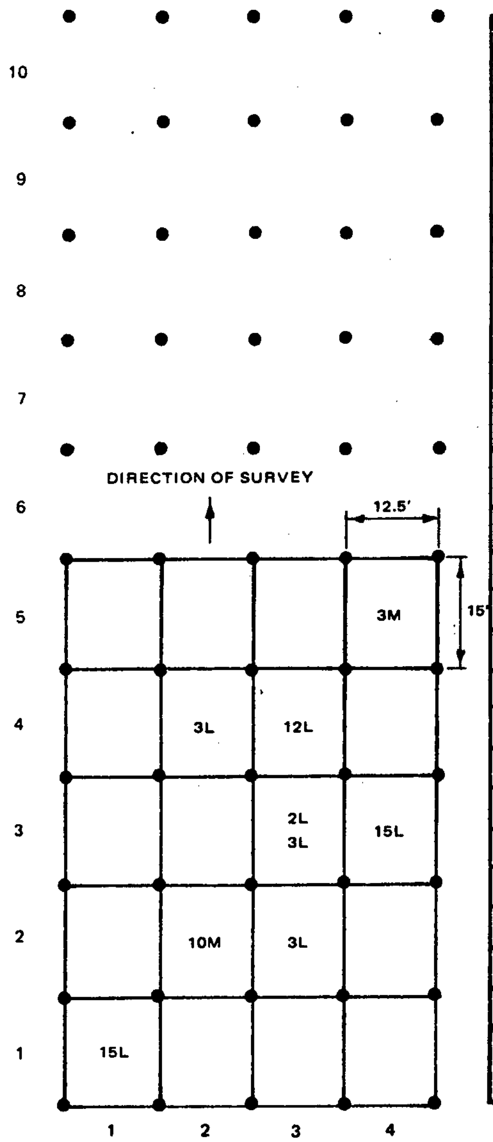


Figure A-8. Example division of flexible pavement feature into sample units

JOINTED RIGID PAVEMENT
CONDITION SURVEY DATA SHEET FOR SAMPLE UNIT

AIRPORT: WORLD INTERNATIONAL		DATE: 5/26/79
FACILITY: RWY 9-27	FEATURE: R3	SAMPLE UNIT: 12
SURVEYED BY: JH/DE		SLAB SIZE: 12.5 X 15 FT



DISTRESS TYPES

1. BLOW-UP
2. CORNER BREAK
3. LONGITUDINAL/ TRANSVERSE/ DIAGONAL CRACK
4. "D" CRACK
5. JOINT SEAL DAMAGE
6. PATCHING, <5 FT^2
7. PATCHING/ UTILITY CUT
8. POPOUTS
9. PUMPING
10. SCALING/MAP CRACK/CRAZING
11. SETTLEMENT/ FAULT
12. SHATTERED SLAB
13. SHRINKAGE CRACK
14. SPALLING -- JOINTS
15. SPALLING -- CORNER

DIST. TYPE	SEV.	NO. SLABS	DENSITY %	DEDUCT VALUE
2	L	1	5	4
3	L	3	15	11
3	M	1	5	11
10	M	1	5	7
12	L	1	5	10
15	L	2	10	3
DEDUCT TOTAL				46
CORRECTED DEDUCT VALUE (CDV)				32

PCI = 100 – CDV = 68

RATING = GOOD

Figure A-9. Jointed rigid pavements - condition survey data sheet

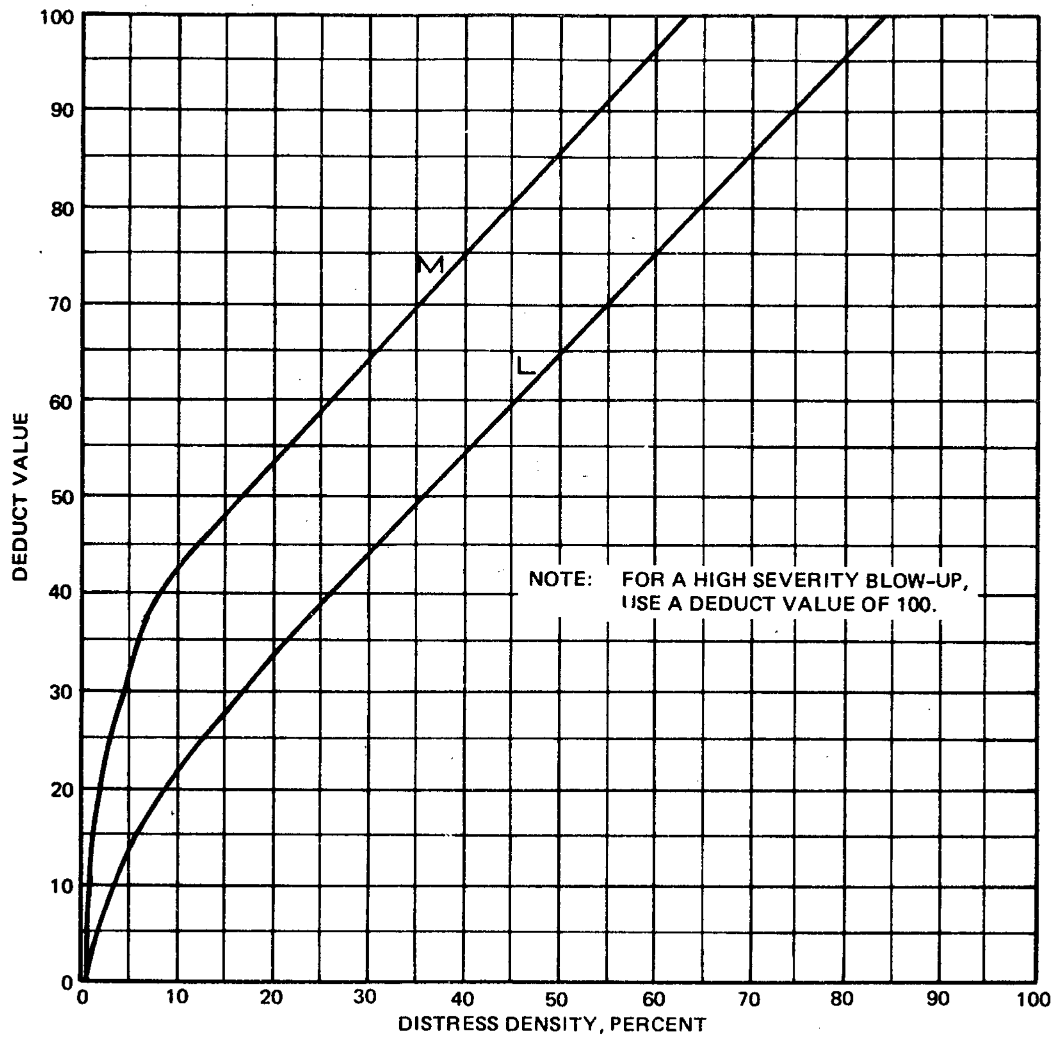


Figure A-10. Rigid pavement deduct values, distress 1, blowup

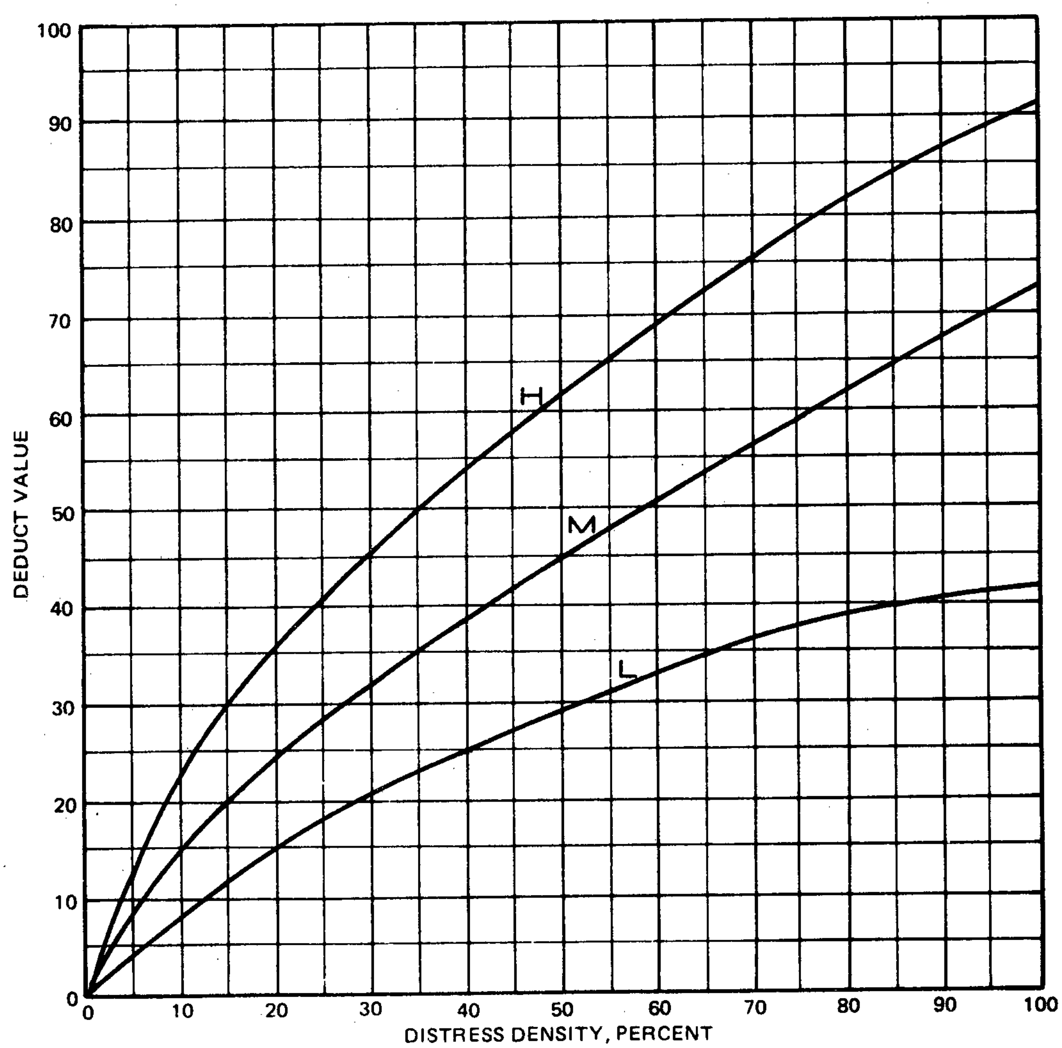


Figure A-11. Rigid pavement deduct values,
distress 2, corner break

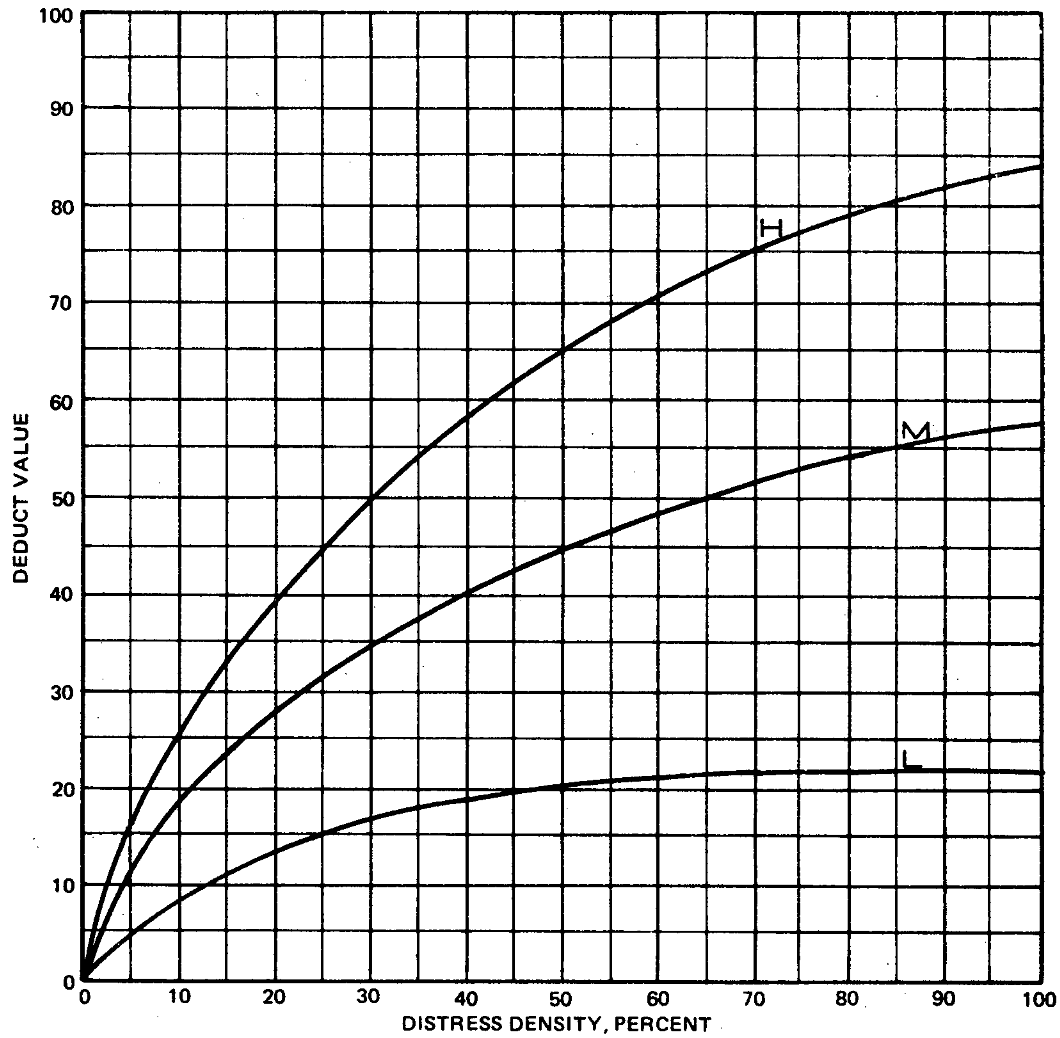


Figure A-12. Rigid pavement deduct values, distress 3, longitudinal/transverse/diagonal cracking

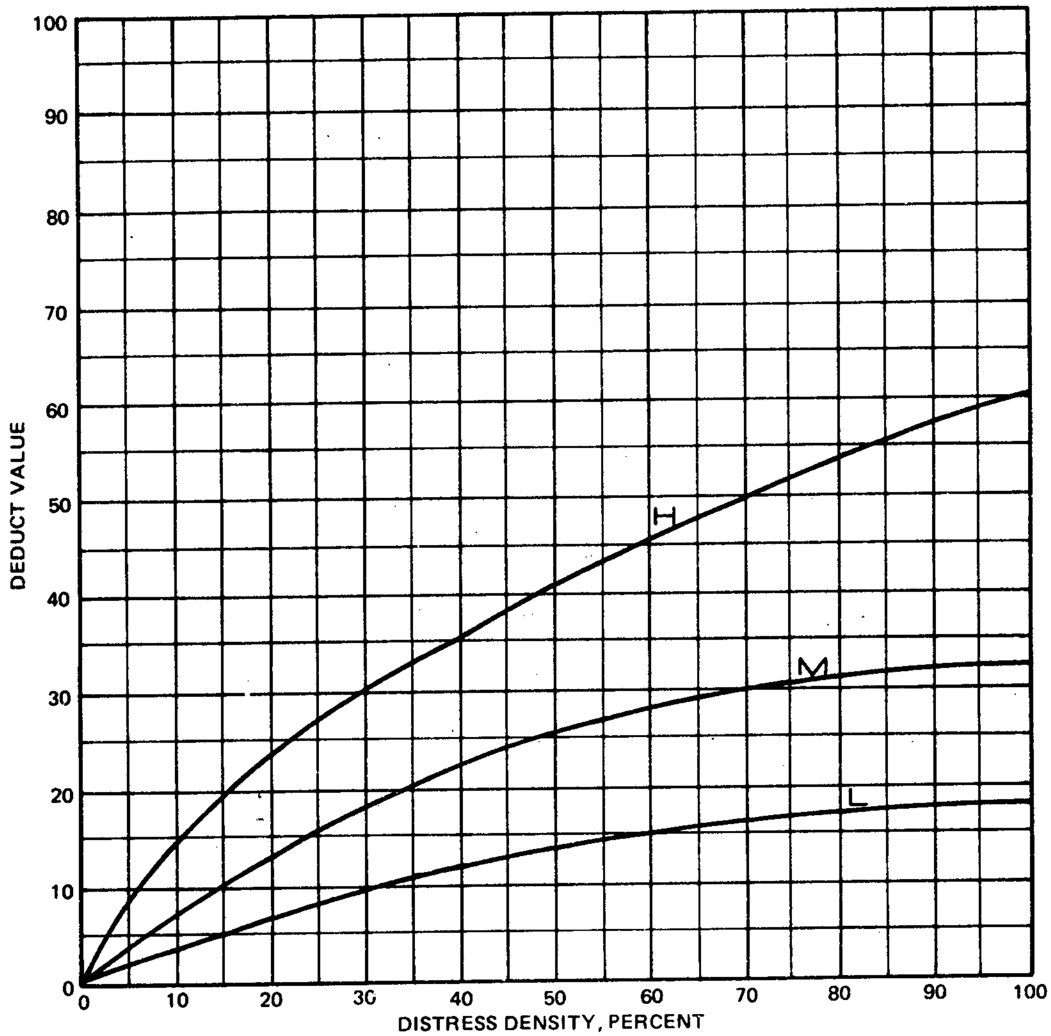


Figure A-13. Rigid pavement deduct values, distress 4, durability cracking

Joint seal damage is not rated by density. The severity of the distress is determined by the sealant's overall condition for a particular section.

The deduct values for the three levels of severity are as follows:

1. High severity - 12 points
2. Medium severity - 7 points
3. Low severity - 2 points

Figure A-14. Rigid pavement deduct values, distress 5, joint seal damage

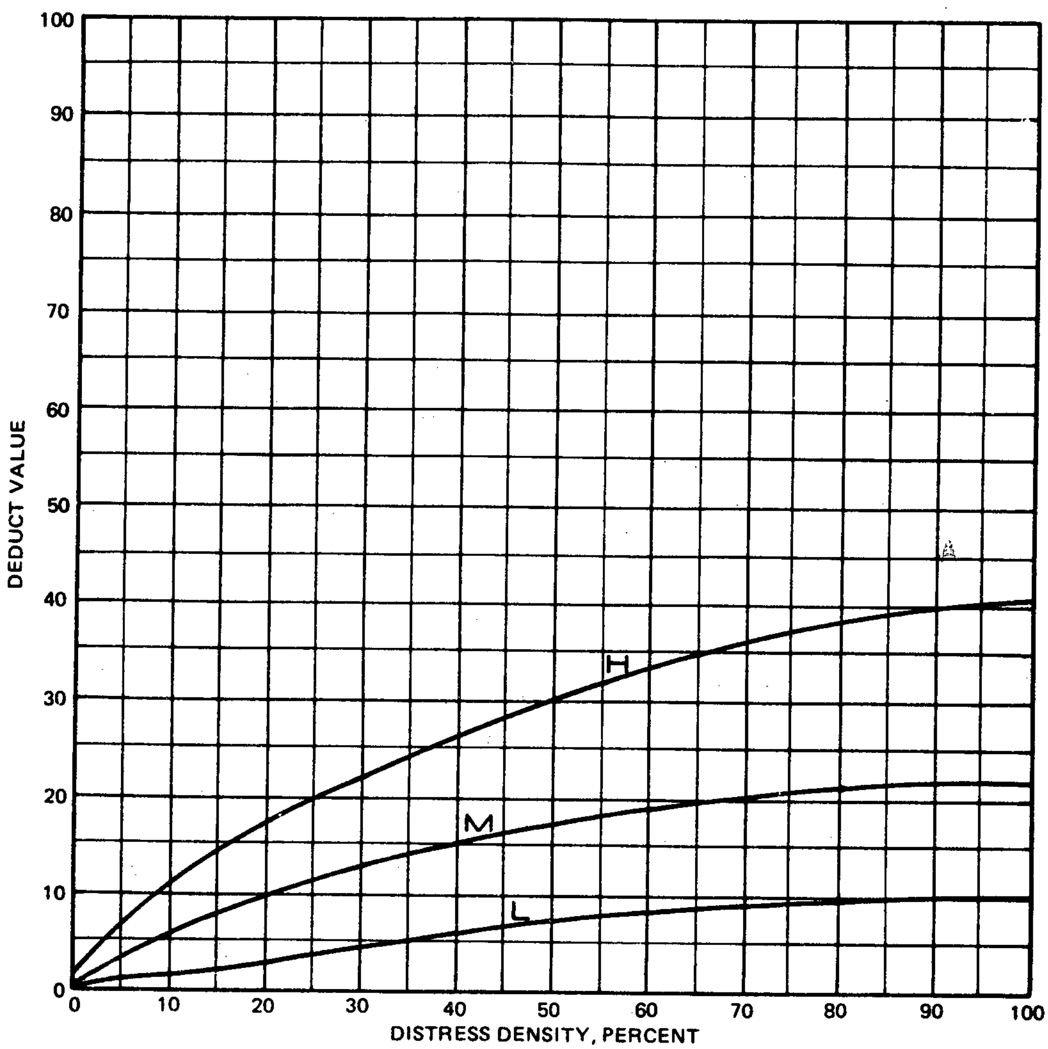


Figure A-15. Rigid pavement deduct values, distress 6, small patch

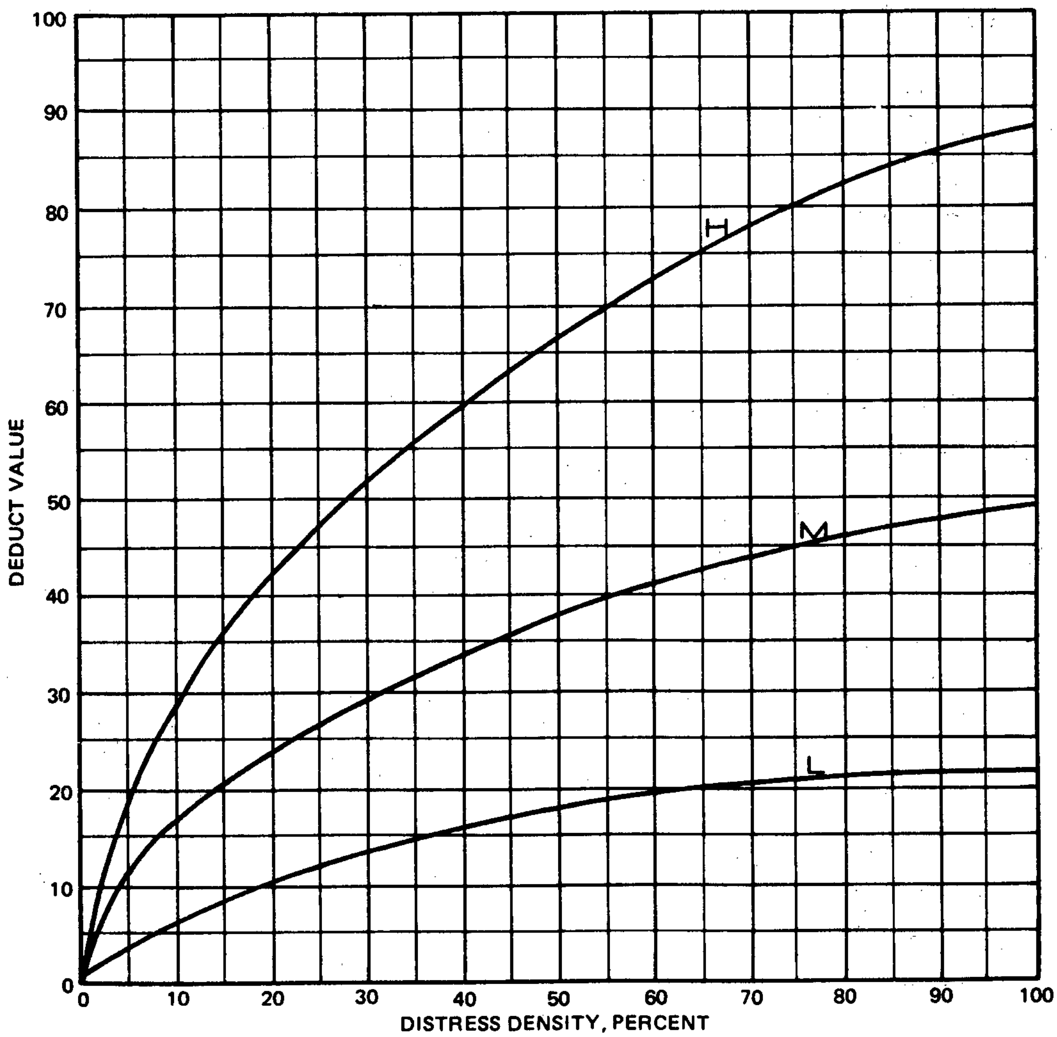


Figure A-16. Rigid pavement deduct values, distress 7, patching/utility cut defect

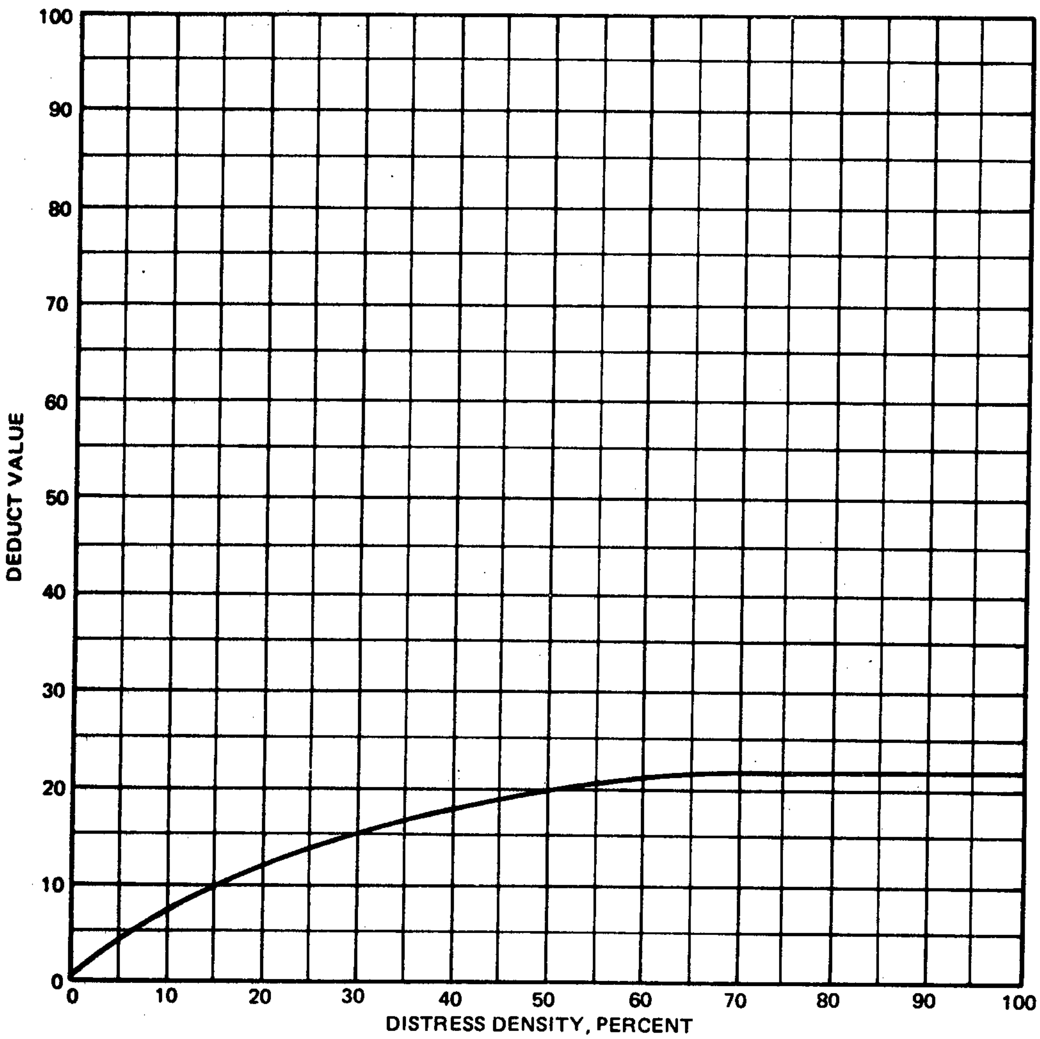


Figure A-17. Rigid pavement deduct values, distress 8, popouts

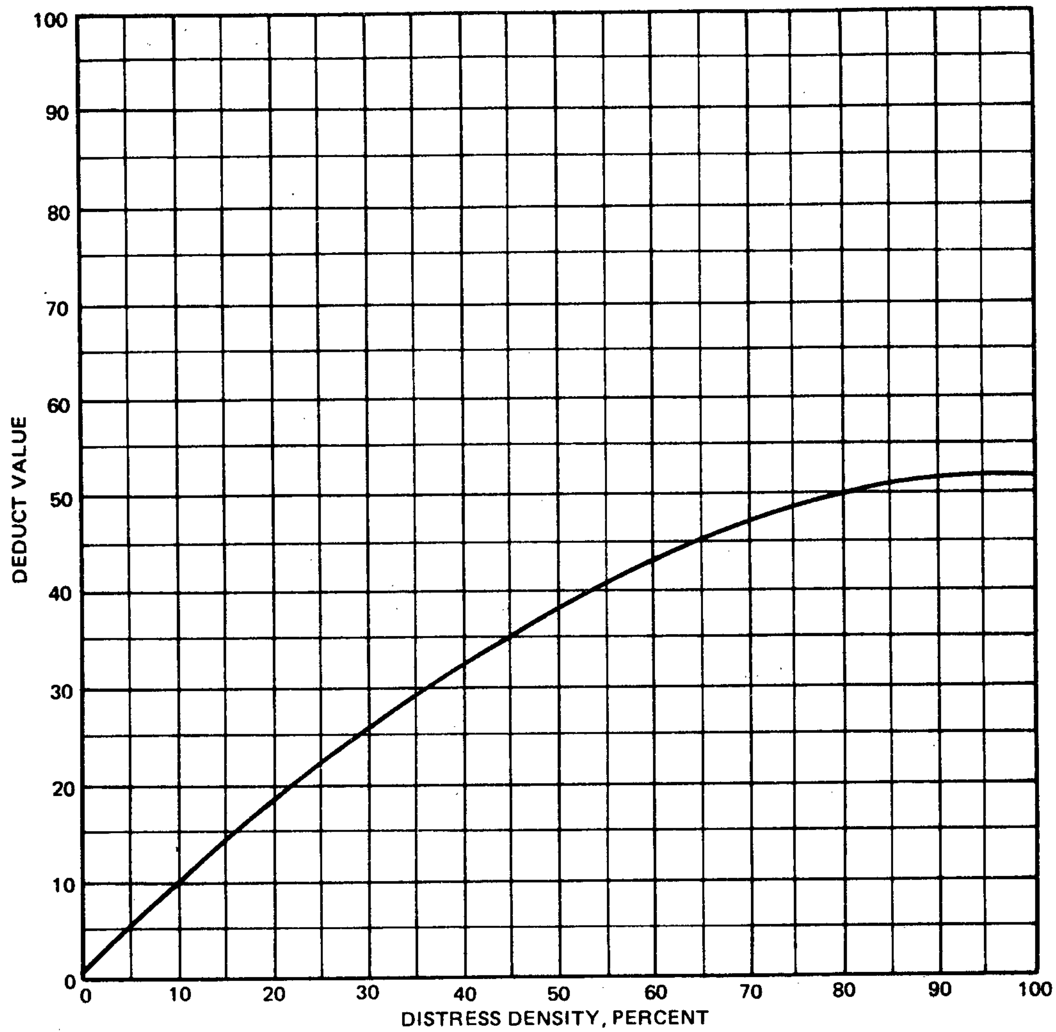


Figure A-18. Rigid pavement deduct values, distress 9, pumping

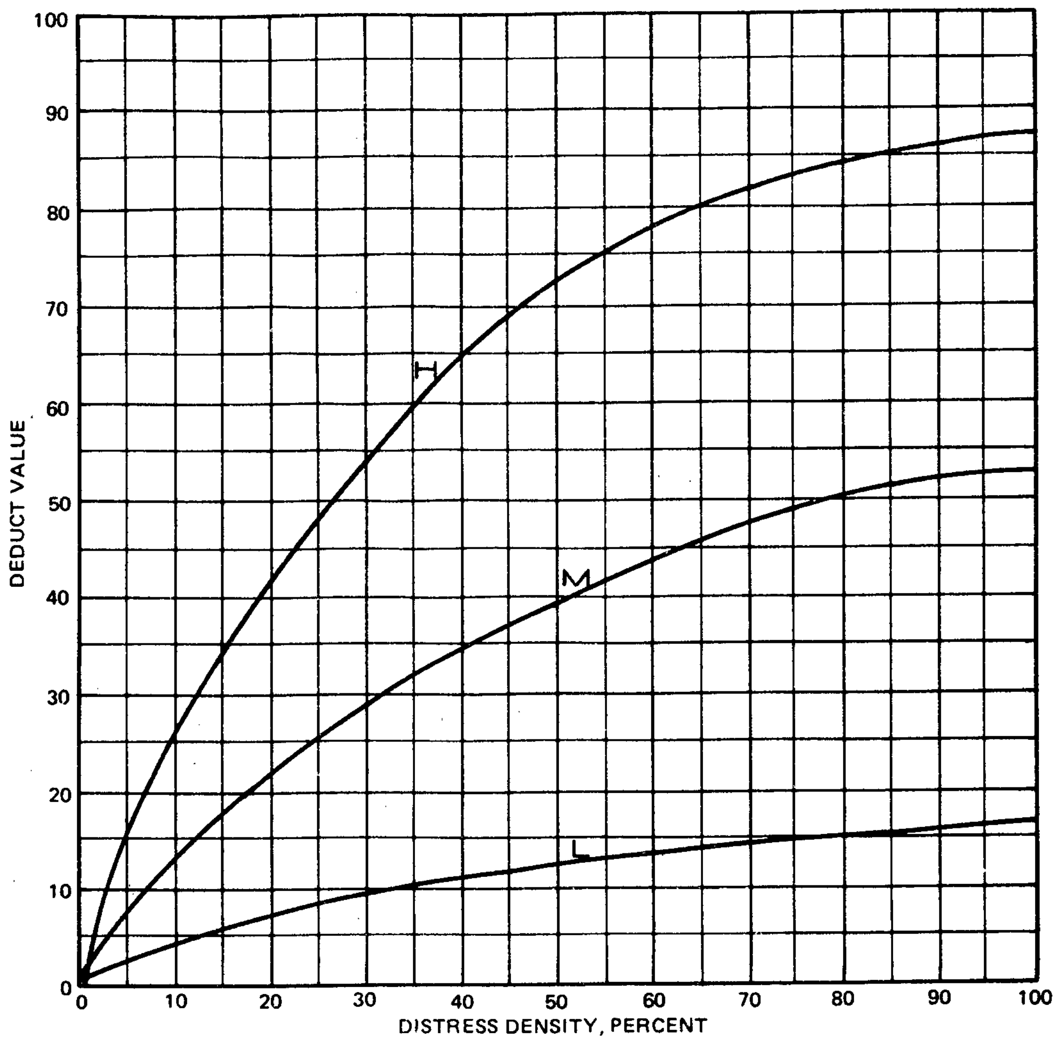


Figure A-19. Rigid pavement deduct values, distress 10, scaling

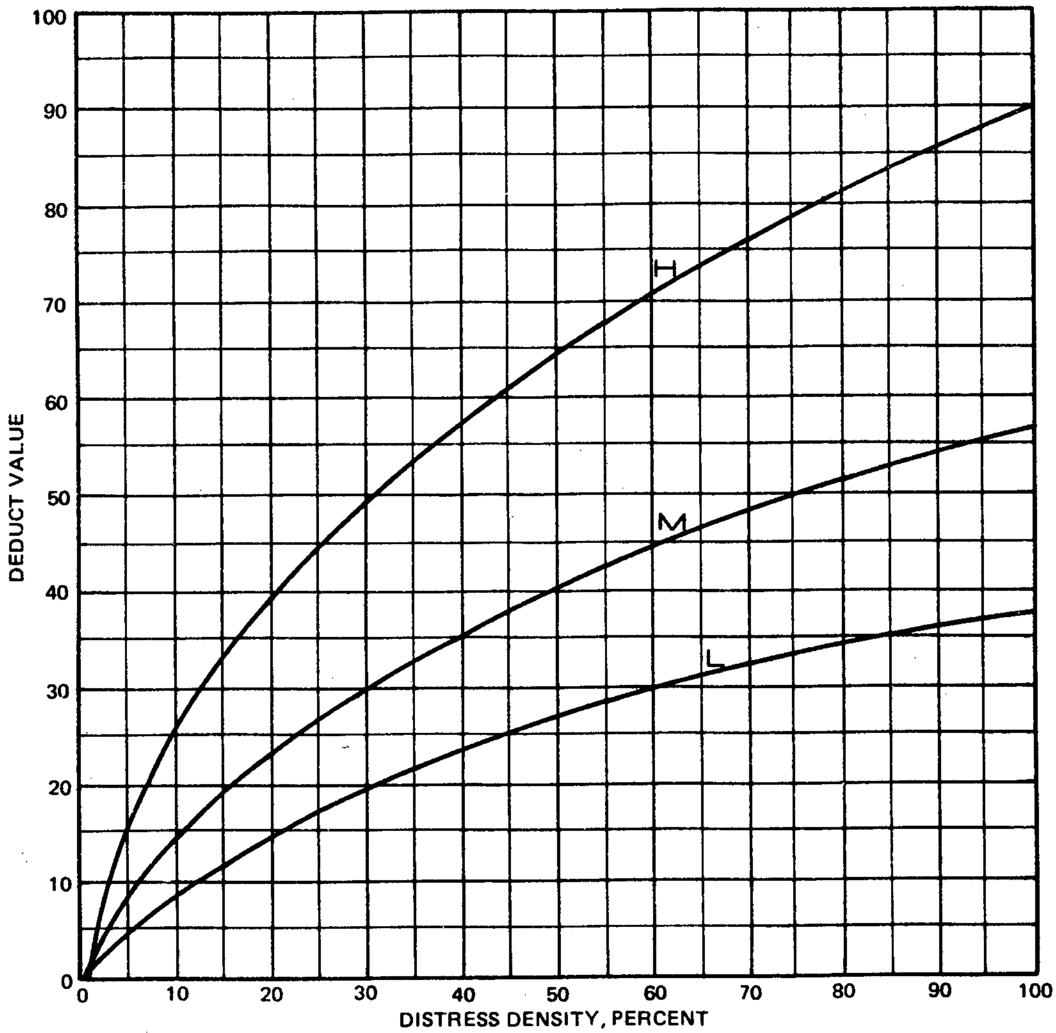


Figure A-20. Rigid pavement deduct values, distress 11, settlement

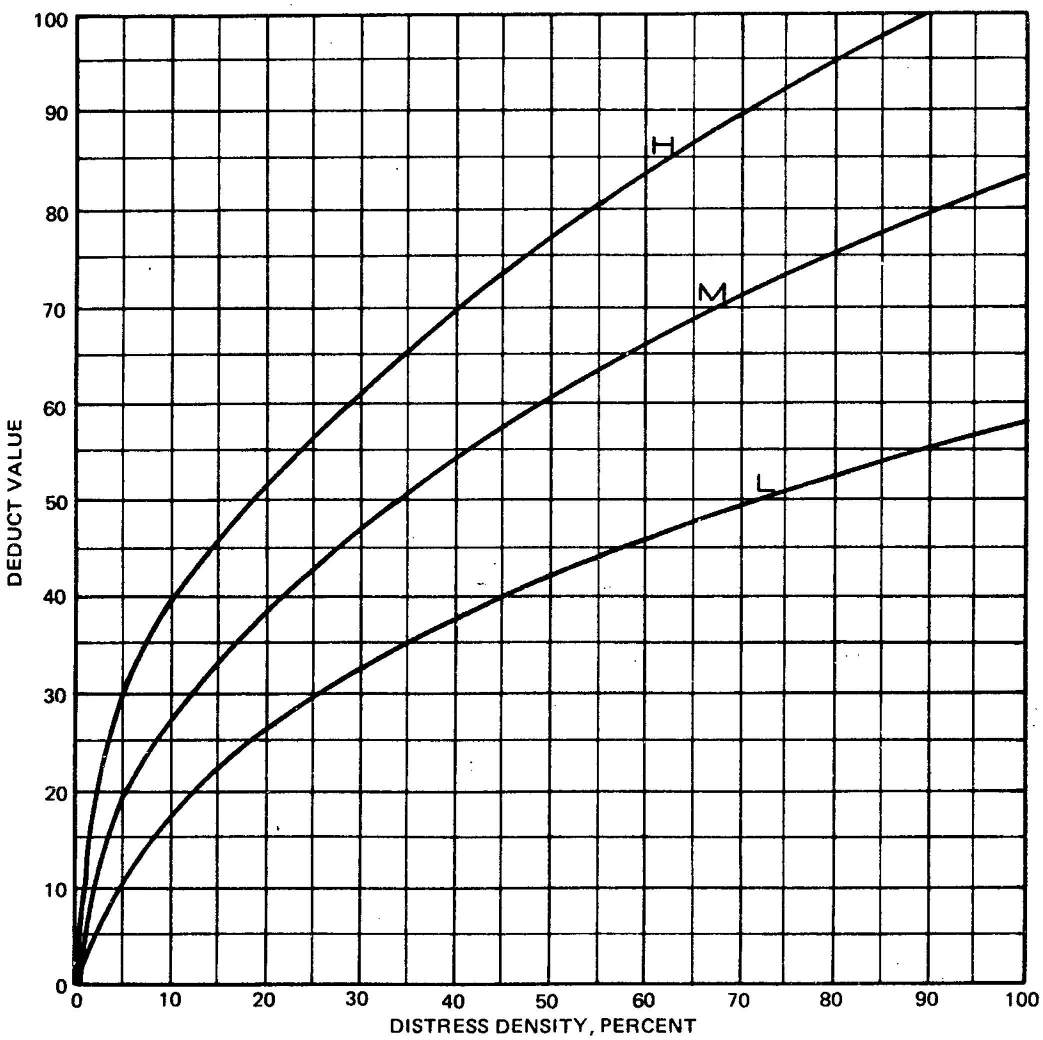


Figure A-21. Rigid pavement deduct values, distress 12, shattered slab

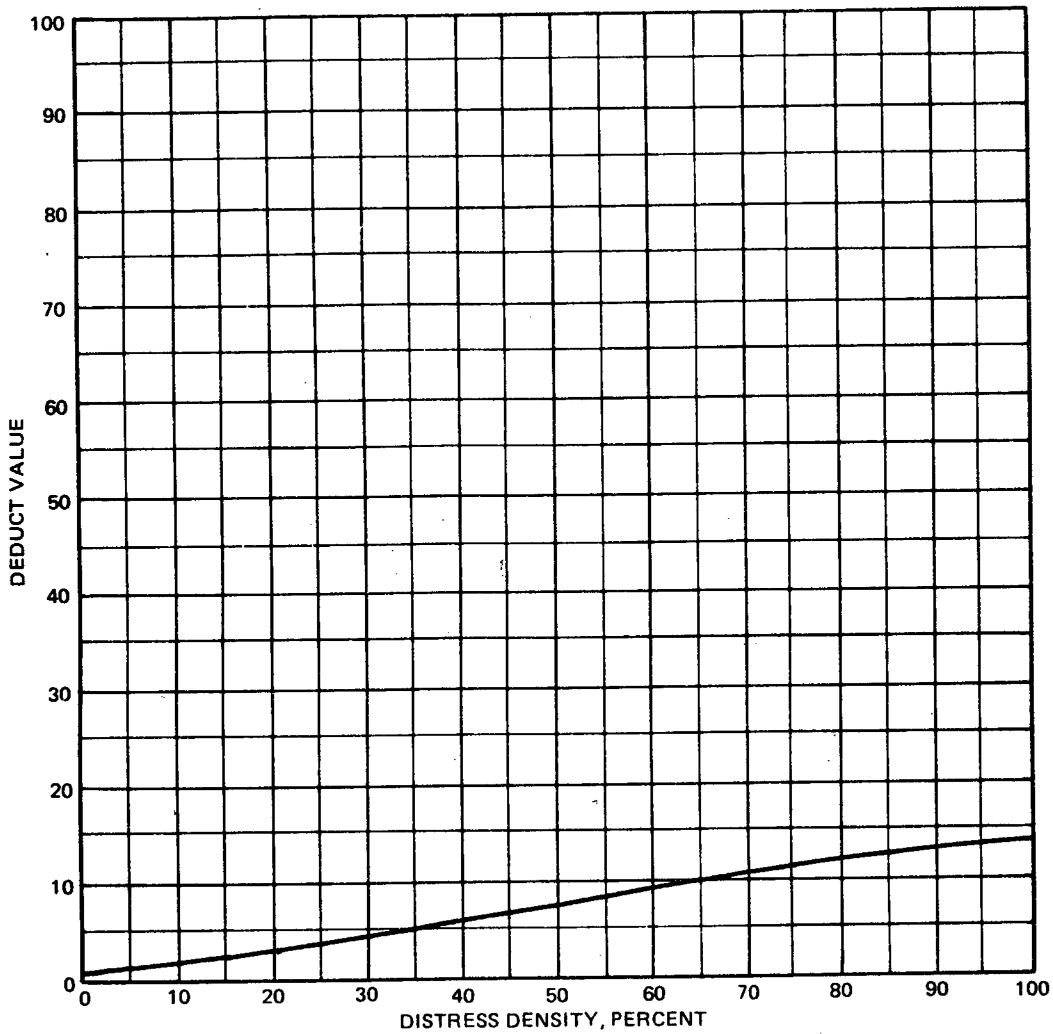


Figure A-22. Rigid pavement deduct values, distress 13, shrinkage cracks

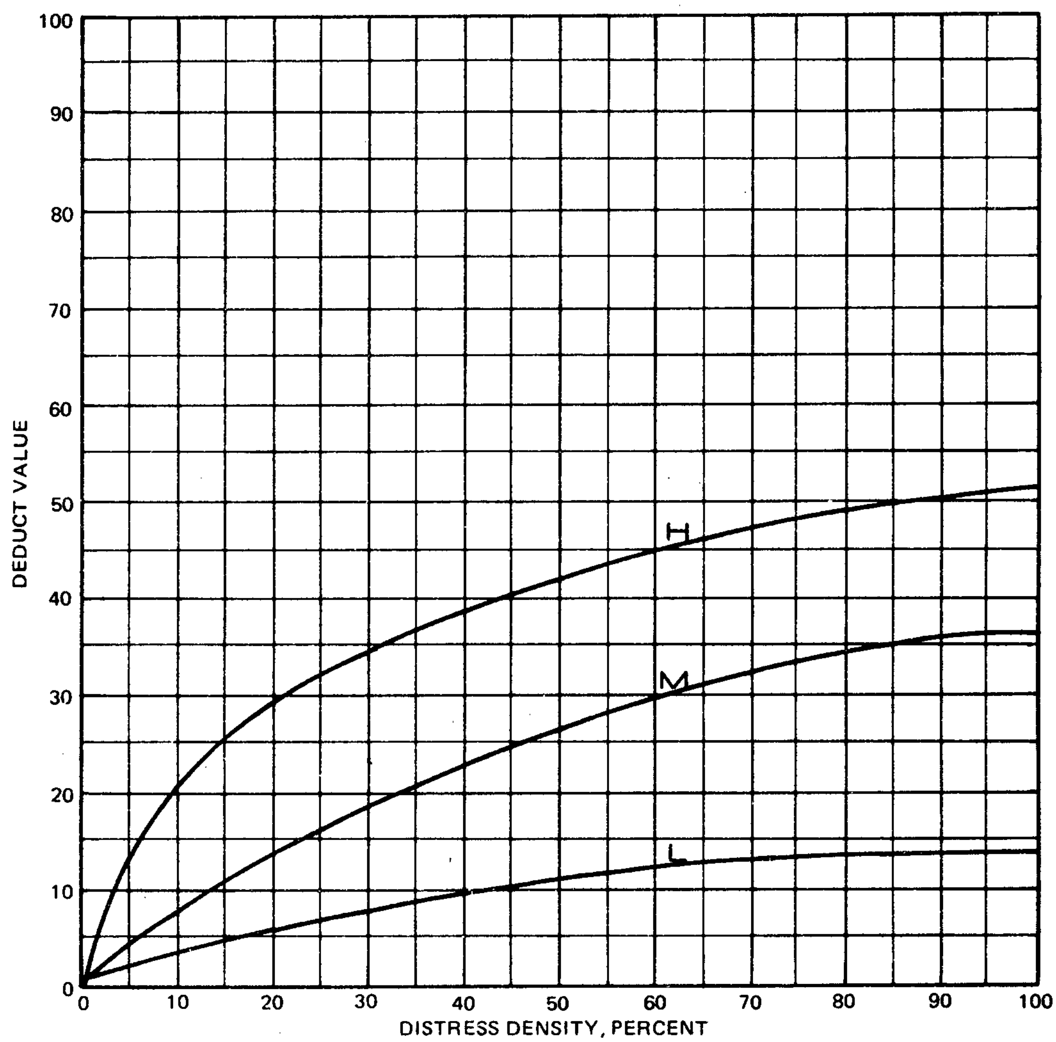


Figure A-23. Rigid pavement deduct values, distress 14, spalling along the joints

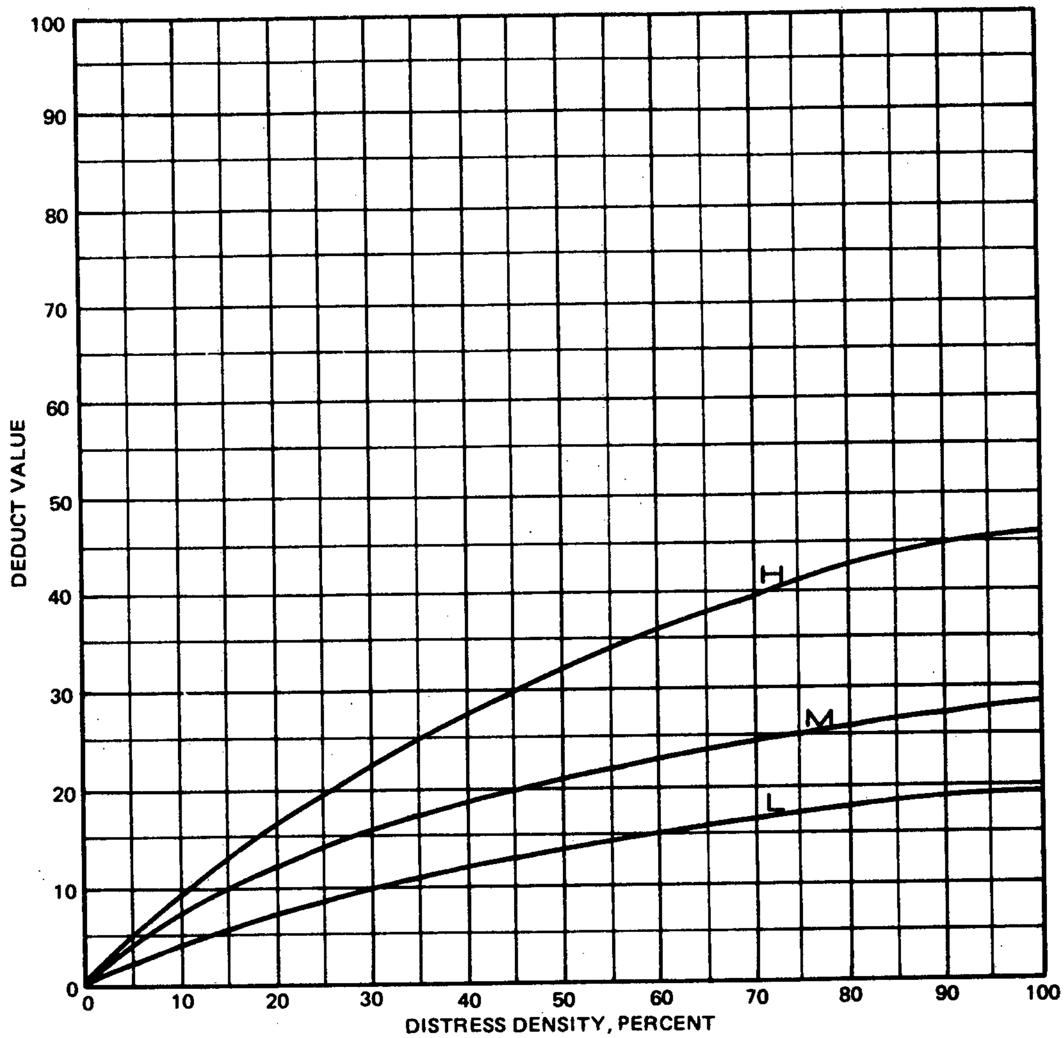


Figure A-24. Rigid pavement deduct values,
distress 15, spalling corner

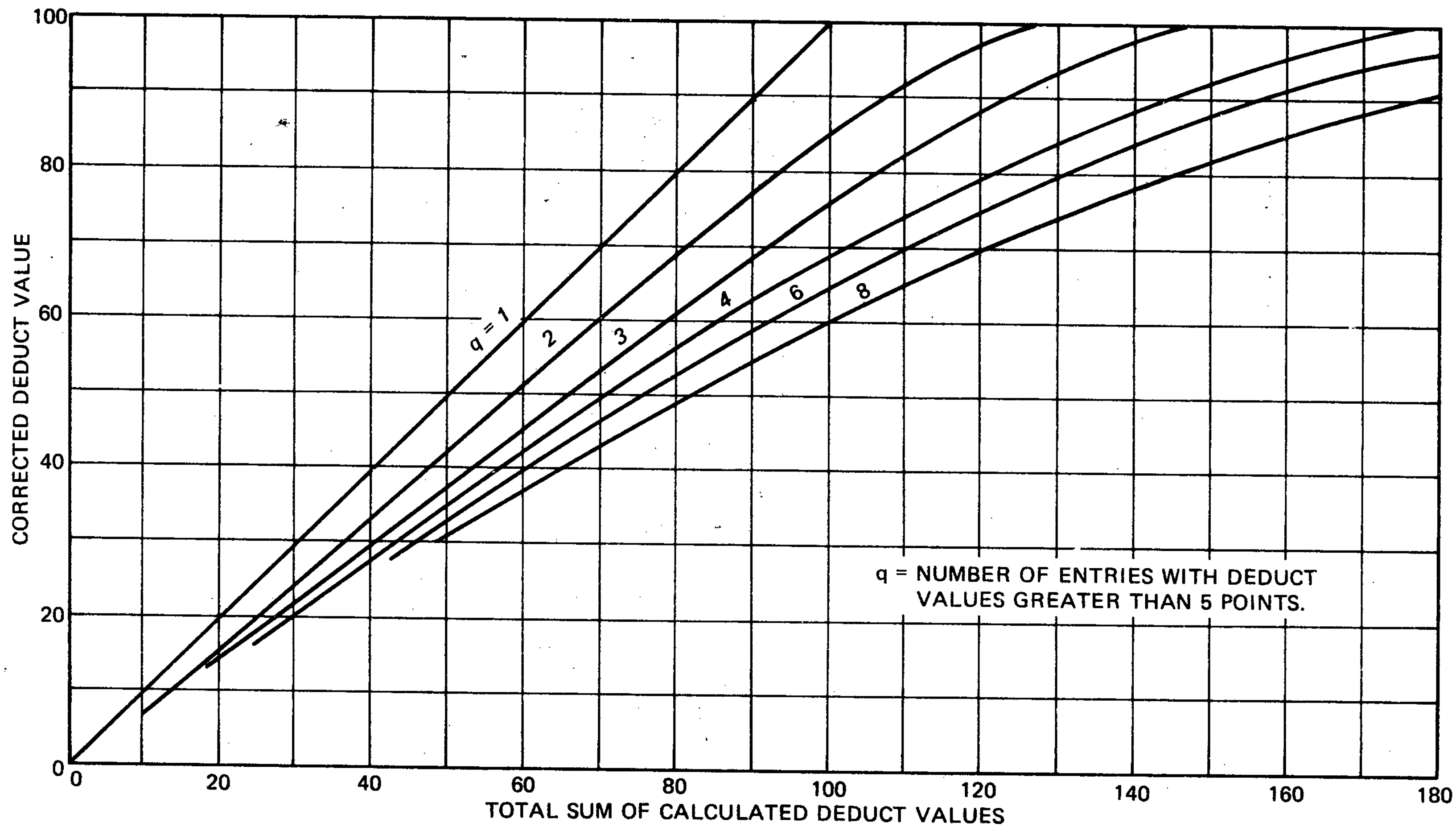


Figure A-25. Corrected deduct values for jointed rigid pavements

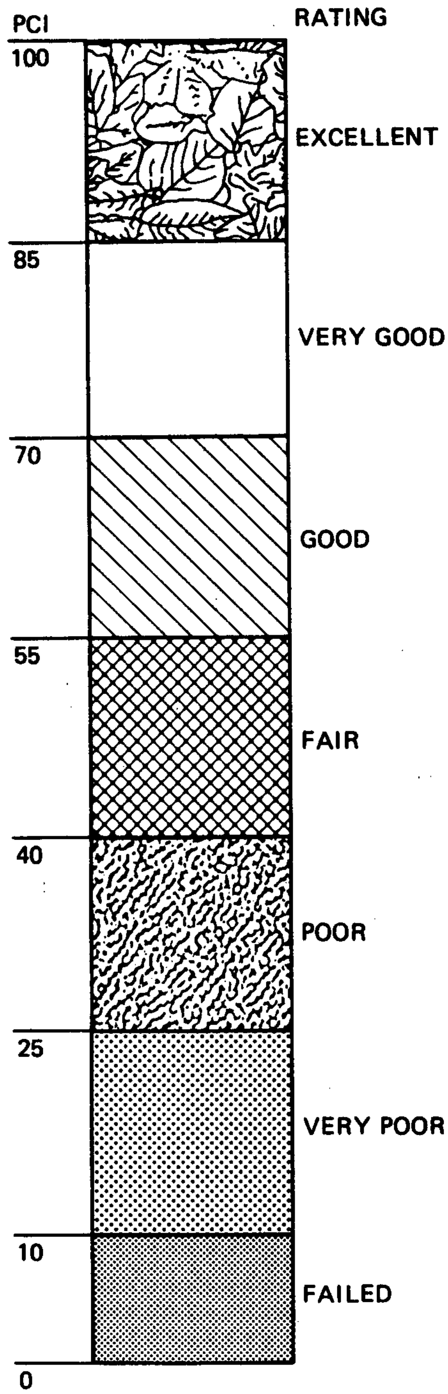


Figure A-26. Airport pavement condition index (PCI) and rating

Airport: World International

Airport Facility: Taxiway 1

Total No. of Sample Units: 5

Date of Survey: 15 March 1979

Sample Unit No.	No. of Slabs	Slab Size	PCI
1	20	12.5 x 15	68
2	20	12.5 x 15	64
3	20	12.5 x 15	64
4	20	12.5 x 15	74
5	20	12.5 x 15	28

Sample Unit No.	No. of Slabs	Slab Size	PCI

Average PCI for Feature: 62

Condition Rating: Good

Figure A-27. Feature summary - jointed rigid pavement

FLEXIBLE PAVEMENT
CONDITION SURVEY DATA SHEET FOR SAMPLE UNIT

AIRPORT: WORLD INTERNATIONAL	DATE: 5/26/79

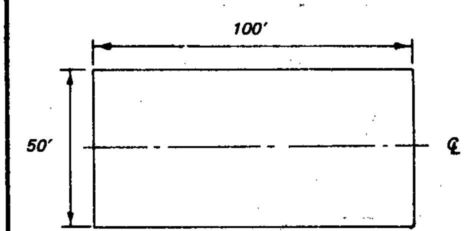
FACILITY: TXY E	FEATURE: T-11	SAMPLE UNIT: 4

SURVEYED BY: JH/DE	AREA OF SAMPLE: 5000 SQ FT

DISTRESS TYPES

1. ALLIGATOR CRACKING
2. BLEEDING
3. BLOCK CRACKING
4. CORRUGATION
5. DEPRESSION
6. JET BLAST
7. JT. REFLECTION (PCC)
8. LONG. & TRANS. CRACKING
9. OIL SPILLAGE
10. PATCHING
11. POLISHED AGGREGATE
12. RAVELING/WEATHERING
13. RUTTING
14. SHOVING FROM PCC
15. SLIPPAGE CRACKING
16. SWELL

SKETCH:



EXISTING DISTRESS TYPES

		1	5	8	12		
		4 X 4 M	6 X 4 L	10 L	3 X 10 M		
		2 X 3 L		5 L			
				15 L			
				5 M			
				10 L			
				5 M			
TOTAL SEVERITY	L	6 SQ FT	24 SQ FT	40 FT			
	M	16 SQ FT		10 FT	30 SQ FT		
	H						

PCI CALCULATION

DISTRESS TYPE	SEVERITY	DENSITY %	DEDUCT VALUE
1	L	0.22	7
1	M	0.32	19
5	L	0.48	2
8	L	0.80	5
8	M	0.20	5
12	M	0.60	7
DEDUCT TOTAL			45
CORRECTED DEDUCT VALUE (CDV)			25

PCI = 100 – CDV = 75

RATING = VERY GOOD

Figure A-28. Flexible pavements - condition survey data sheet

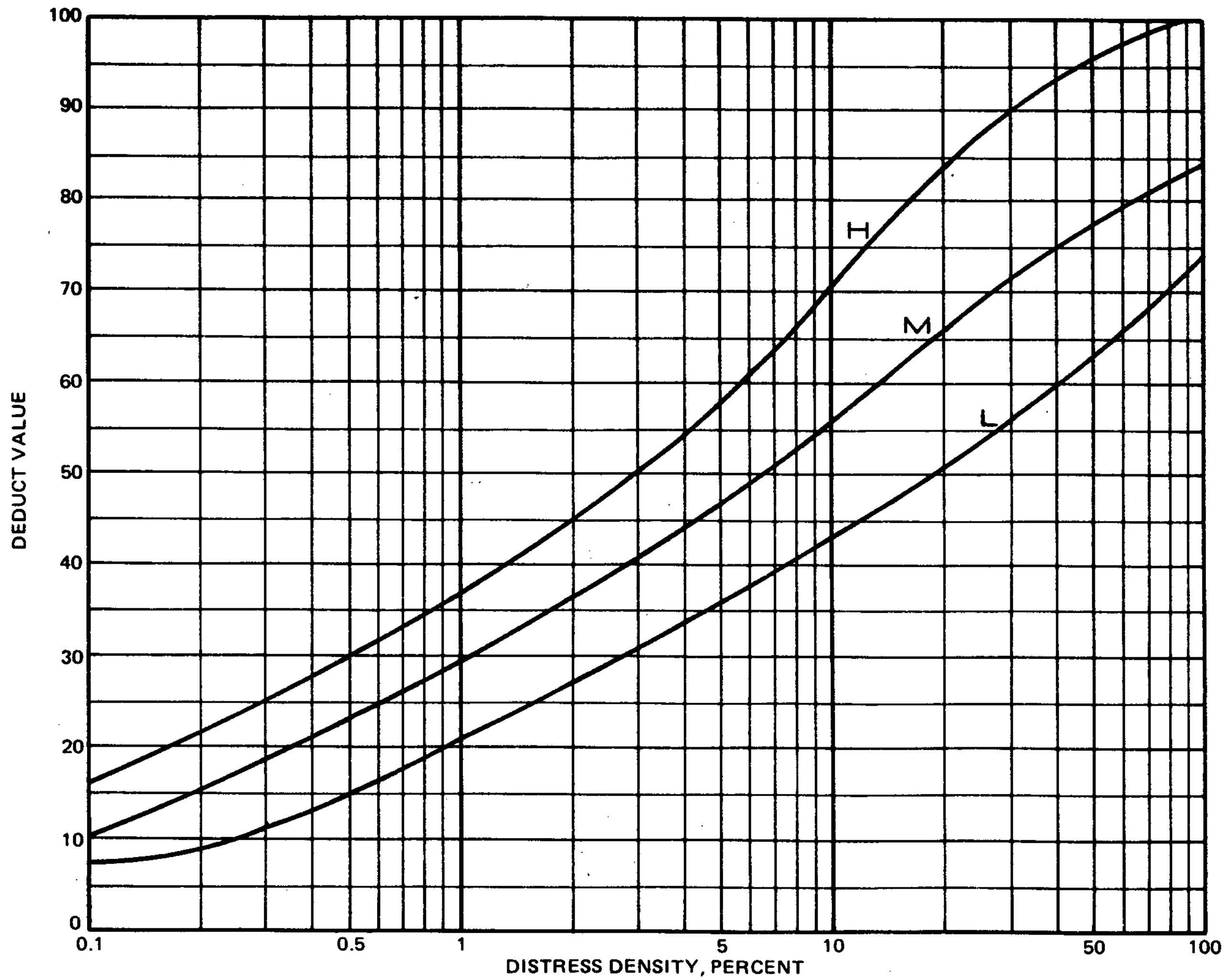


Figure A-29. Flexible pavement deduct values, distress 1, alligator cracking

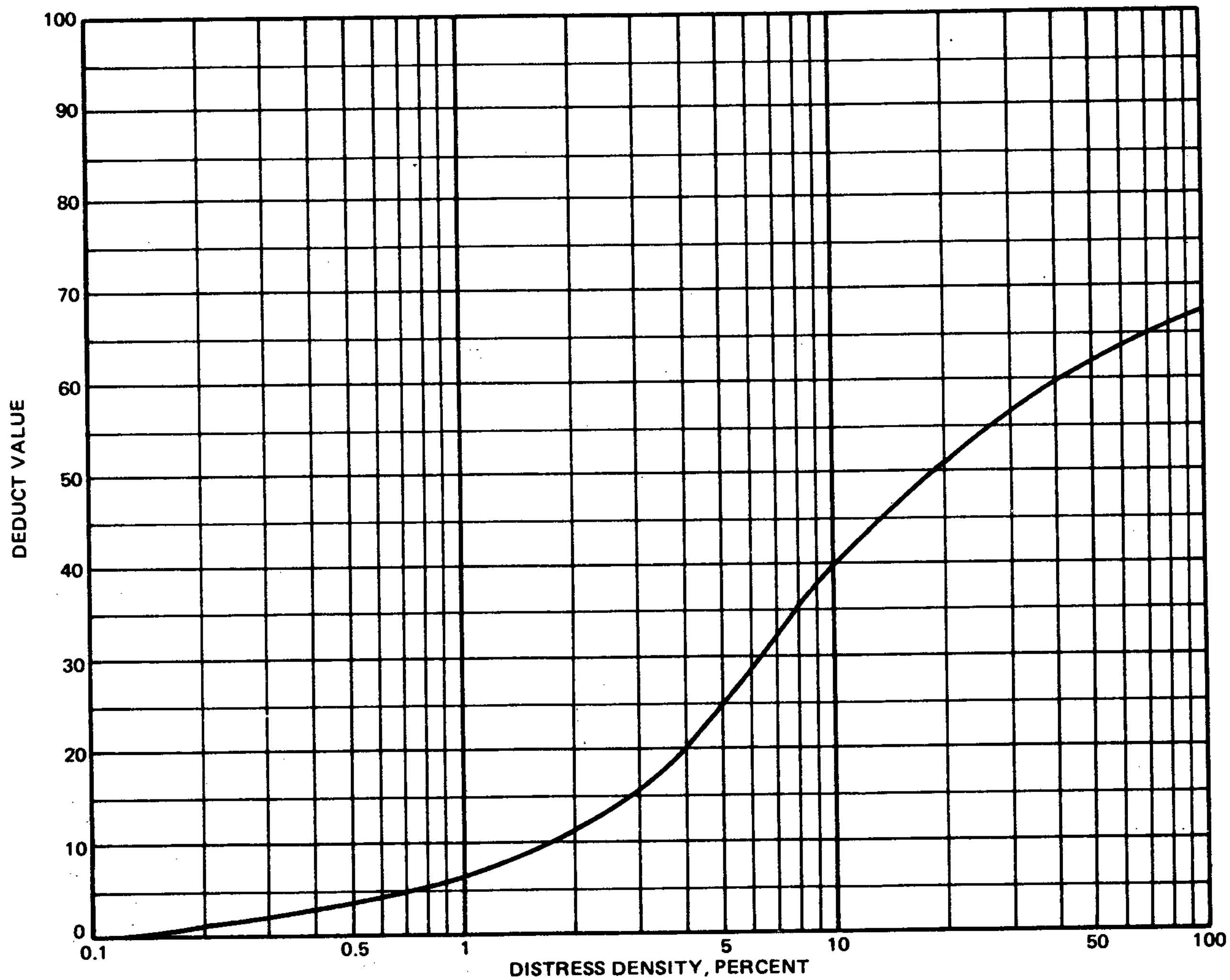


Figure A-30. Flexible pavement deduct values, distress 2, bleeding

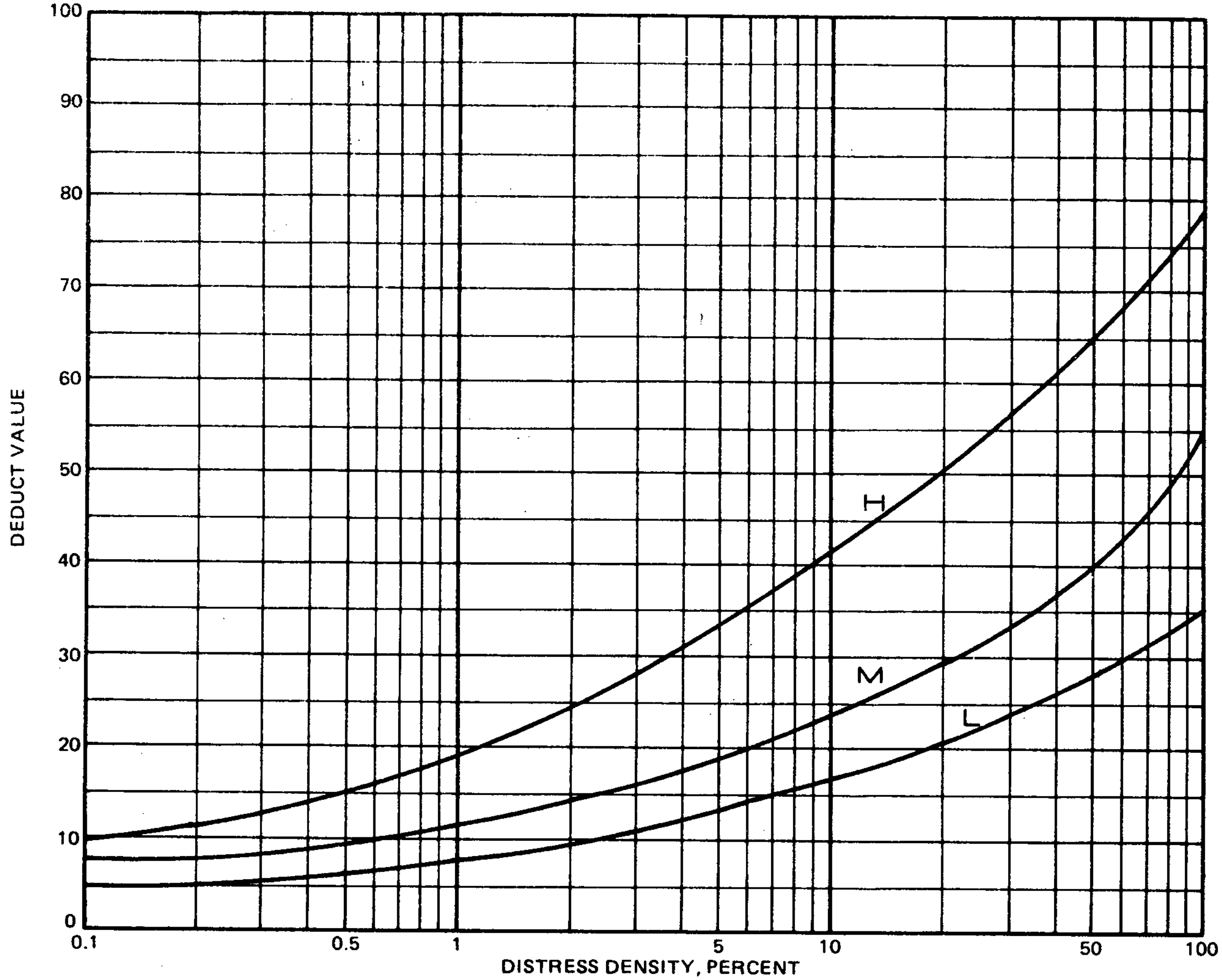


Figure A-31. Flexible pavement deduct values, distress 3, block cracking

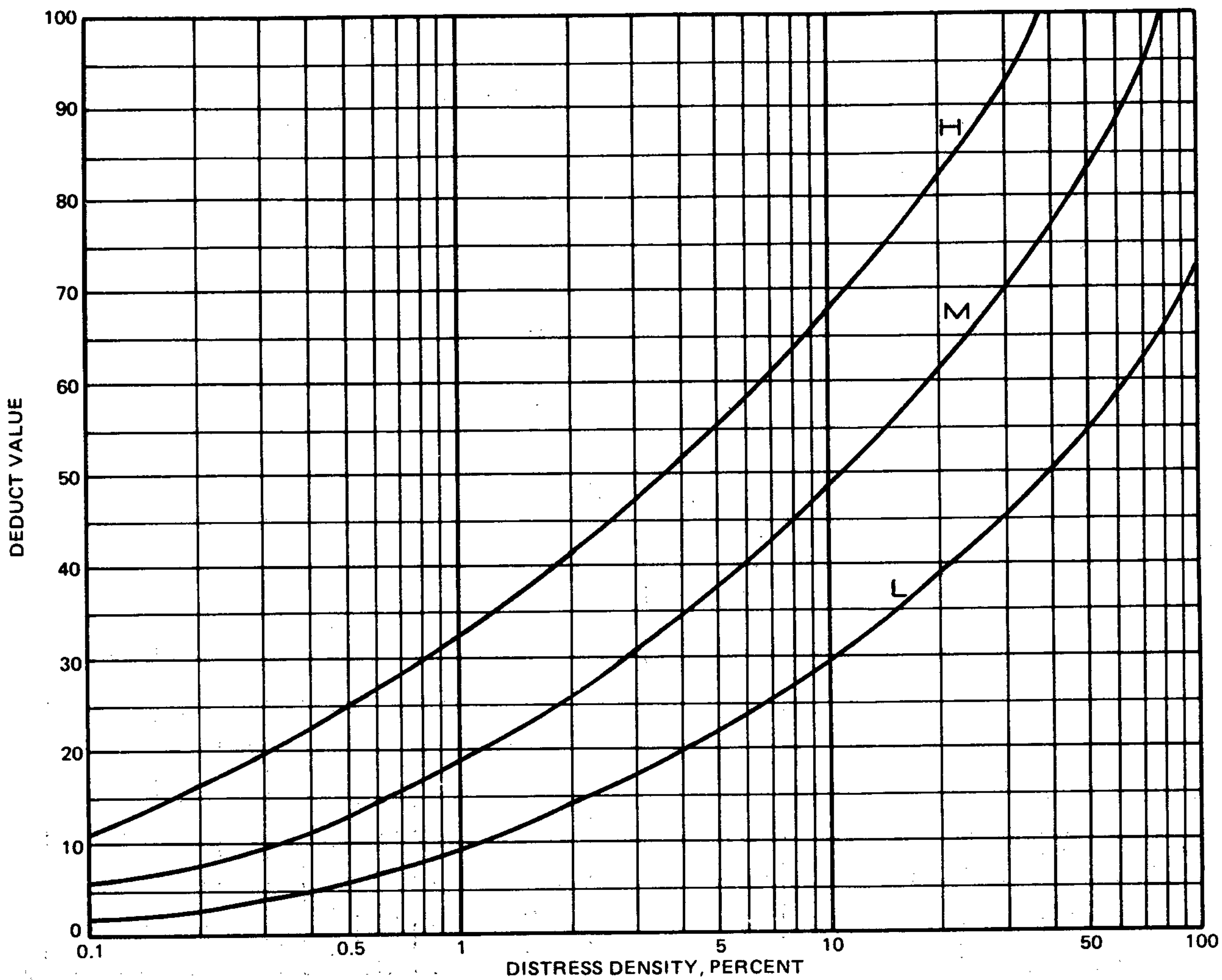


Figure A-32. Flexible pavement deduct values, distress 4, corrugation

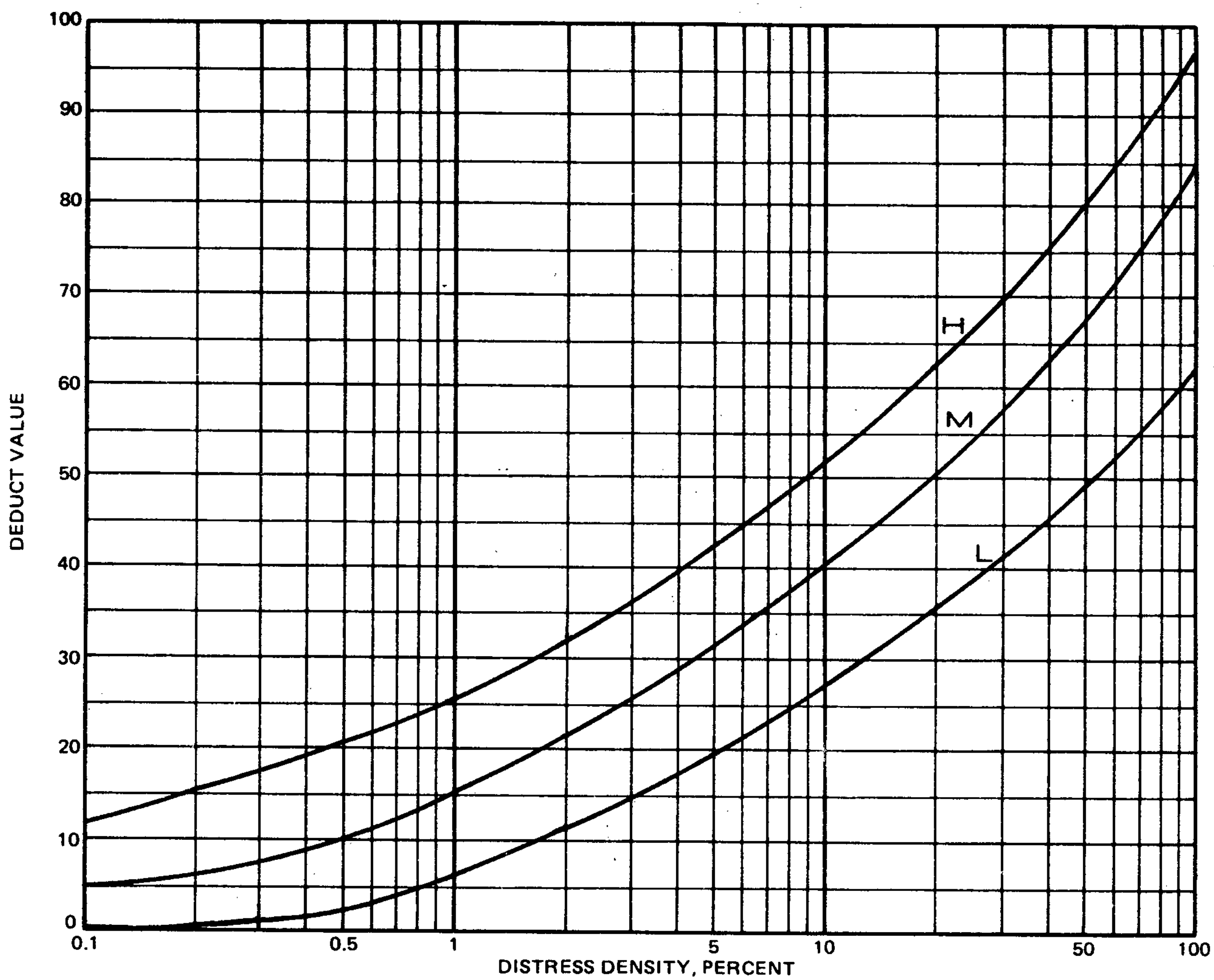


Figure A-33. Flexible pavement deduct values, distress 5, depression

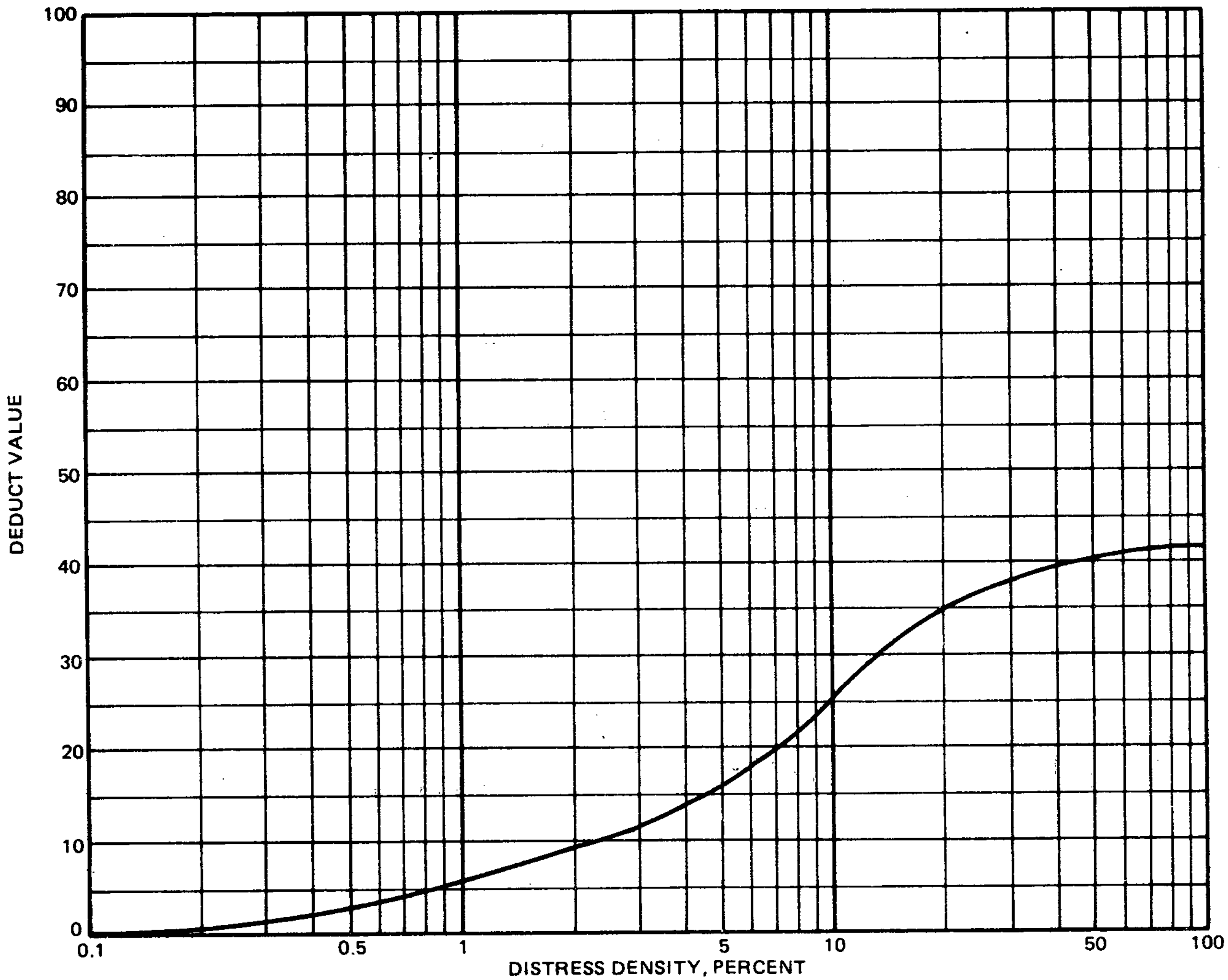


Figure A-34. Flexible pavement deduct values, distress 6, jet blast erosion

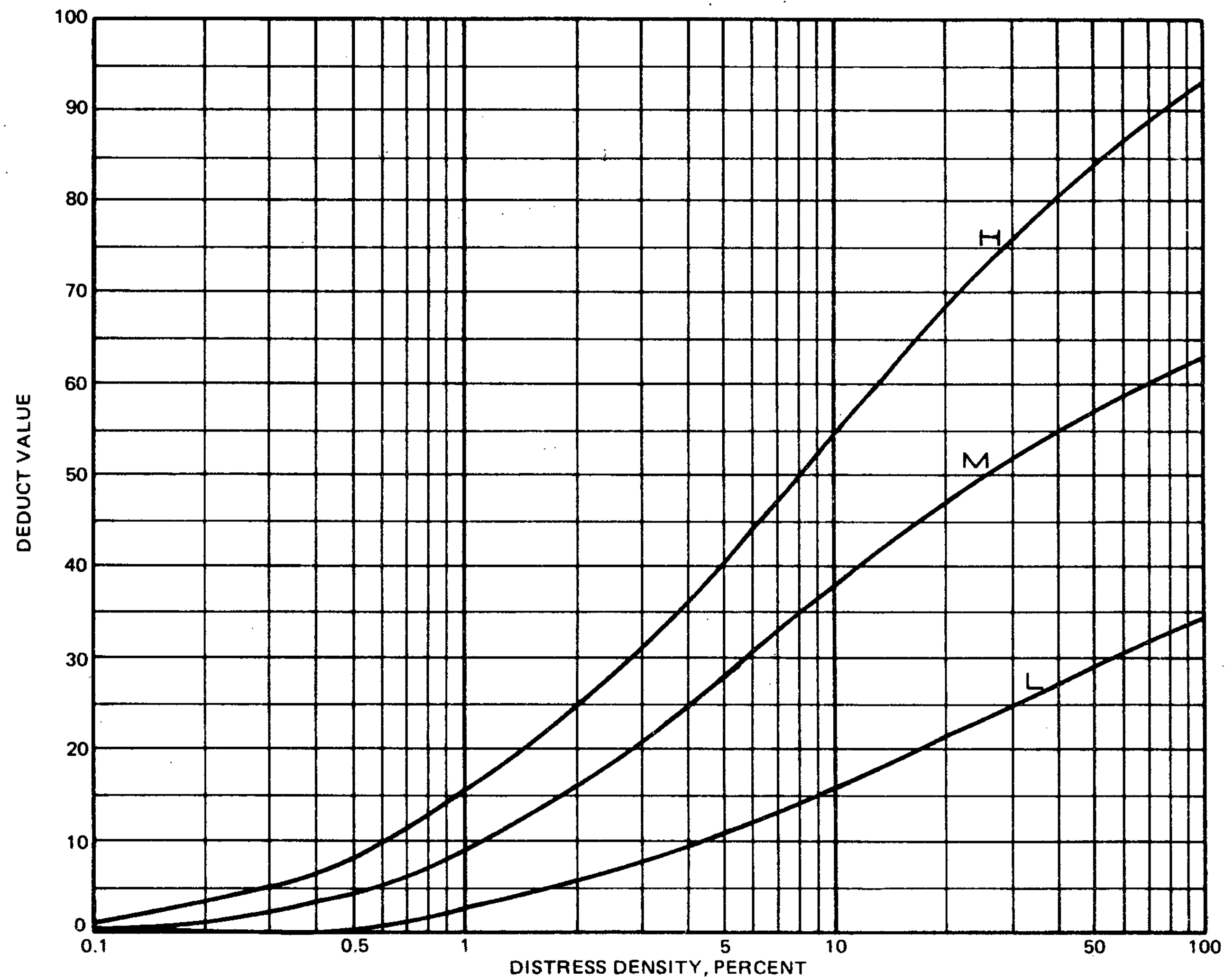


Figure A-35. Flexible pavement deduct values, distress 7, joint reflection cracking

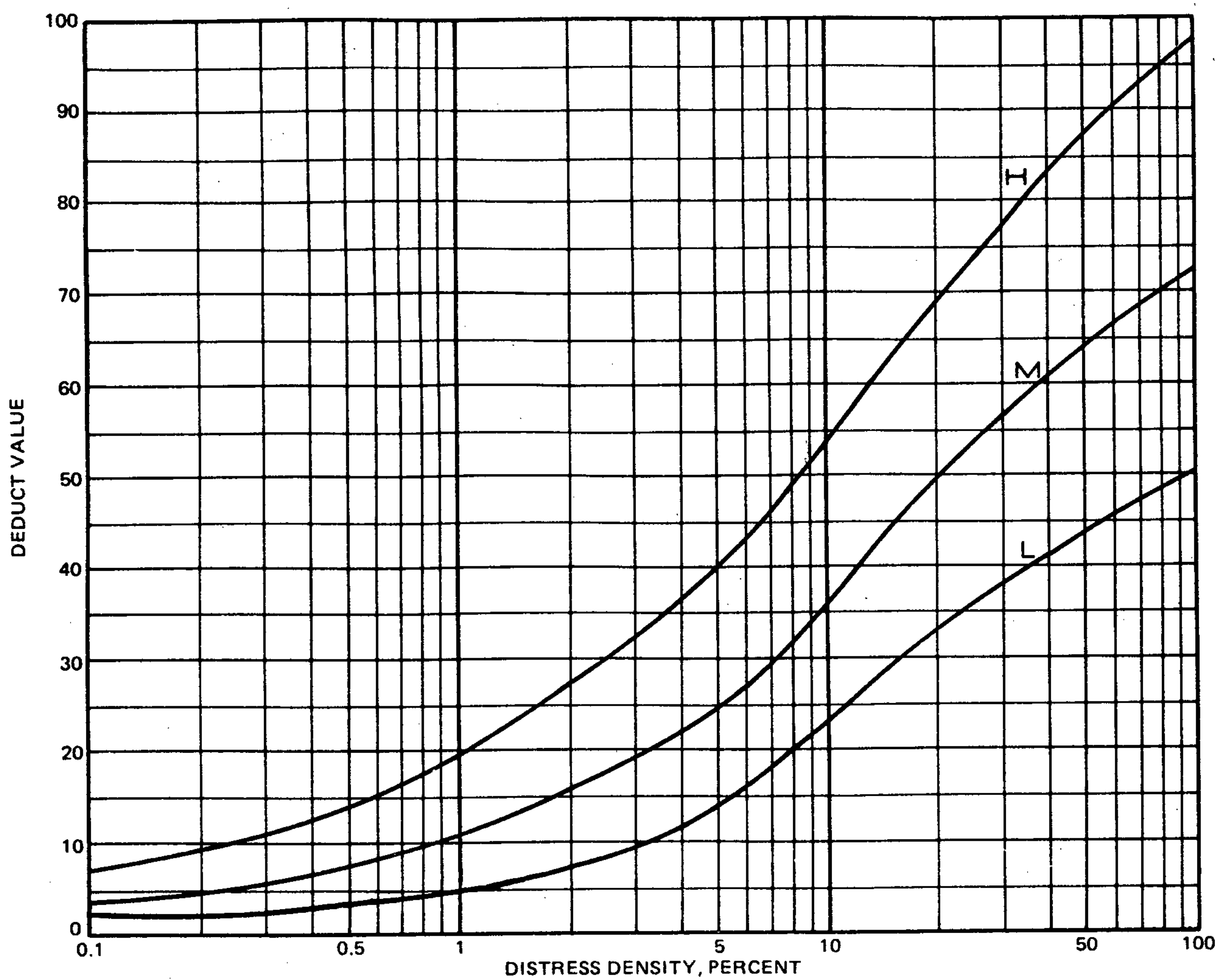


Figure A-36. Flexible pavement deduct values, distress 8, longitudinal and transverse cracking

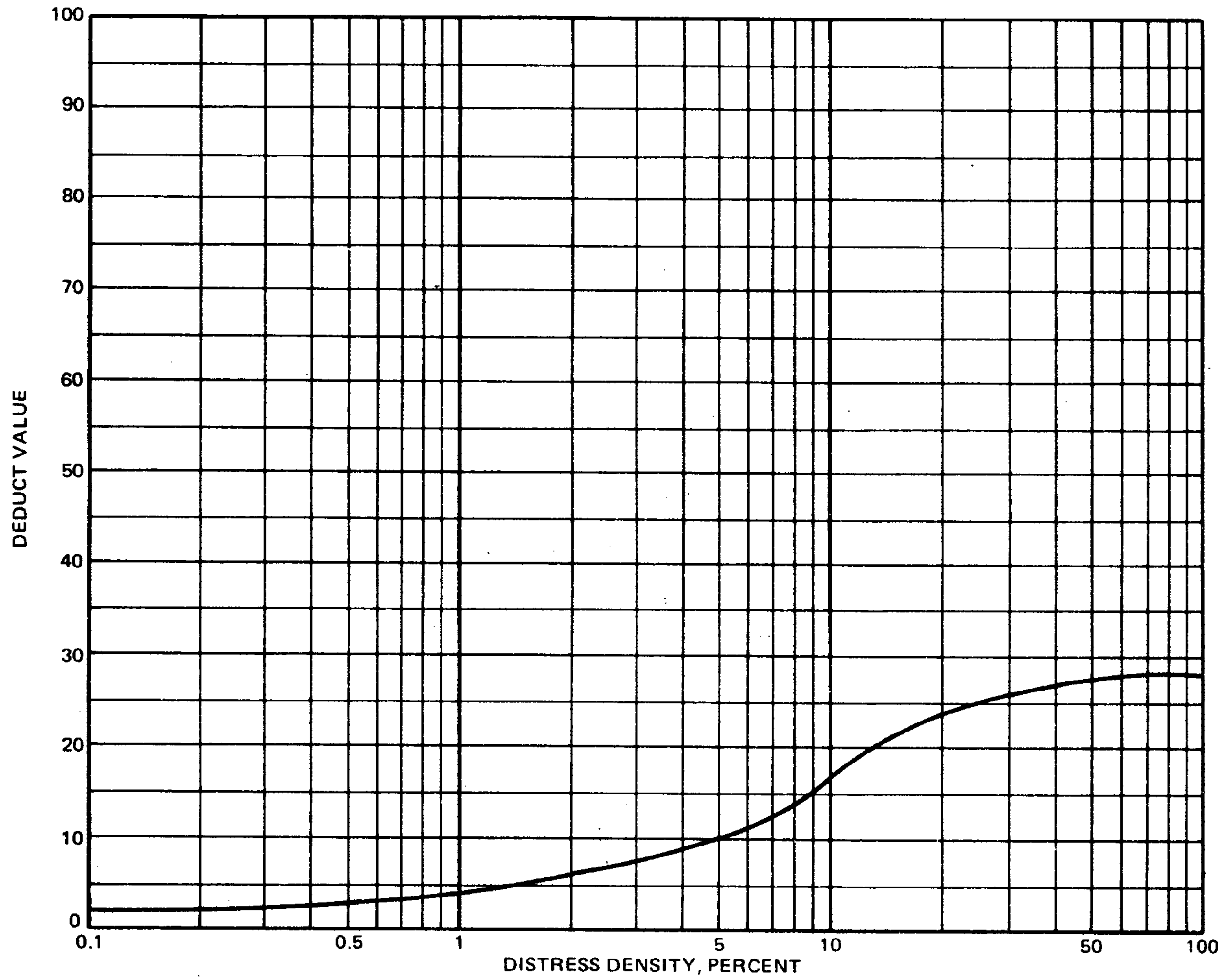


Figure A-37. Flexible pavement deduct values, distress 9, oil spillage

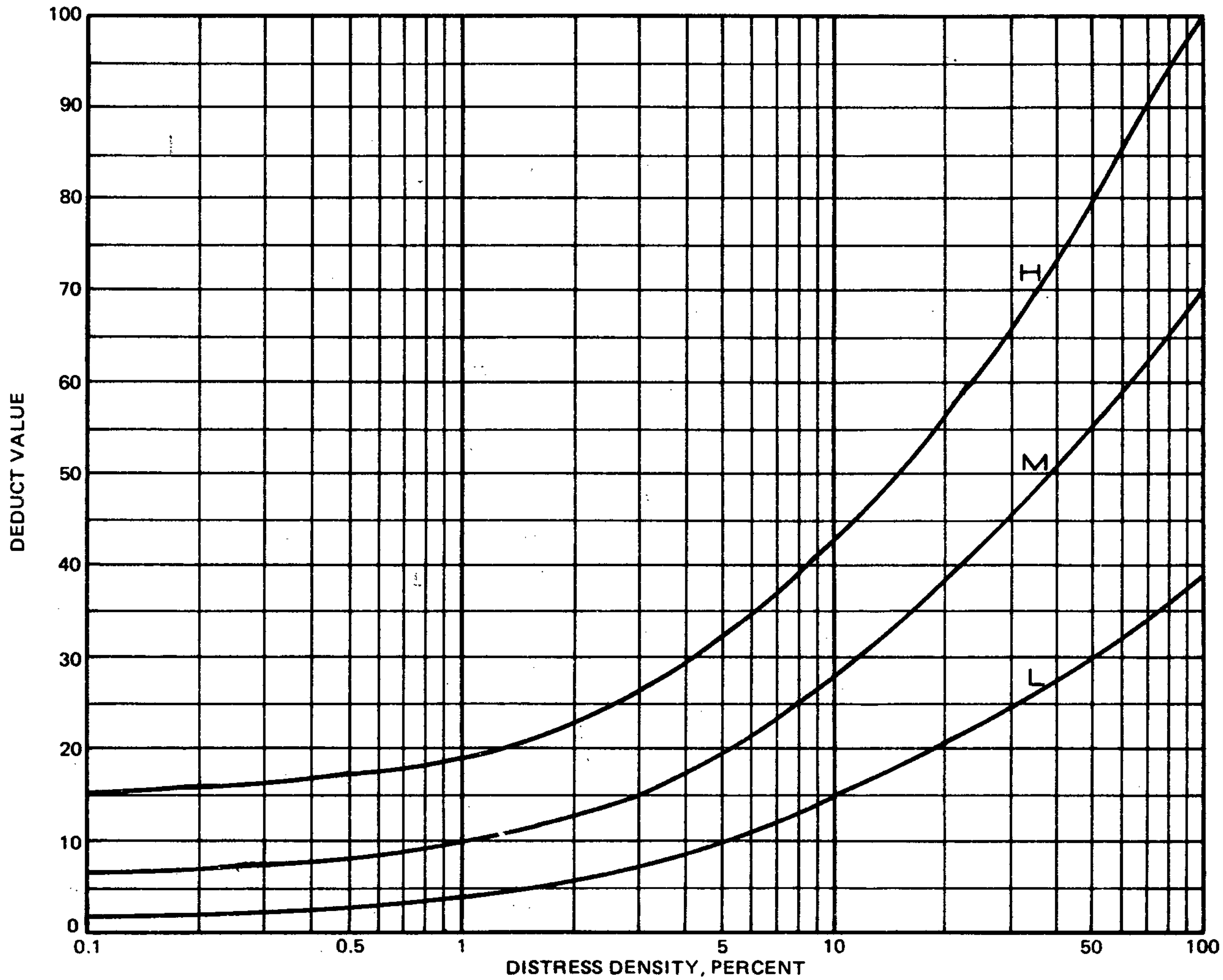


Figure A-38. Flexible pavement deduct values, distress 10, patching and utility cut

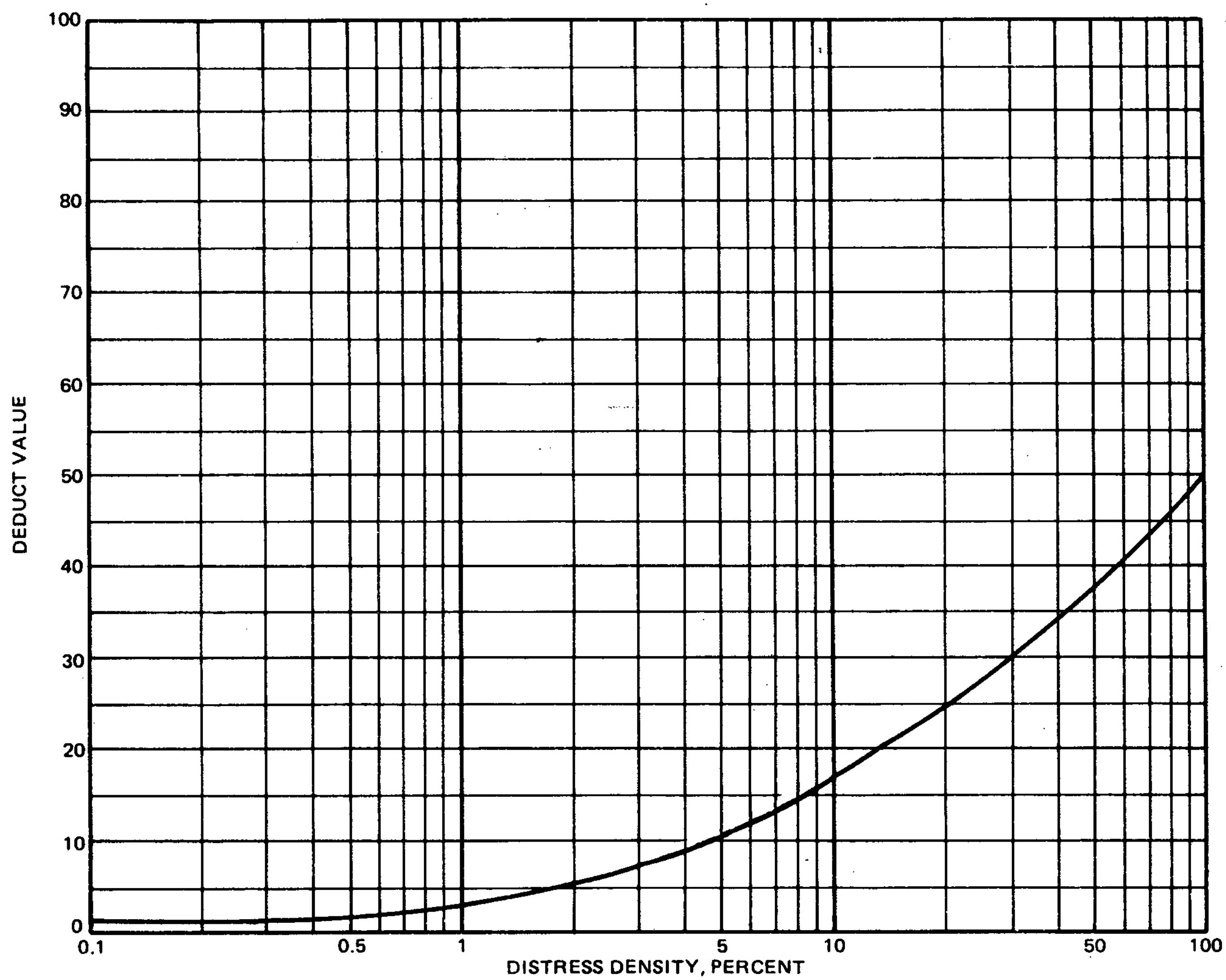


Figure A-39. Flexible pavement deduct values, distress 11, polished aggregate

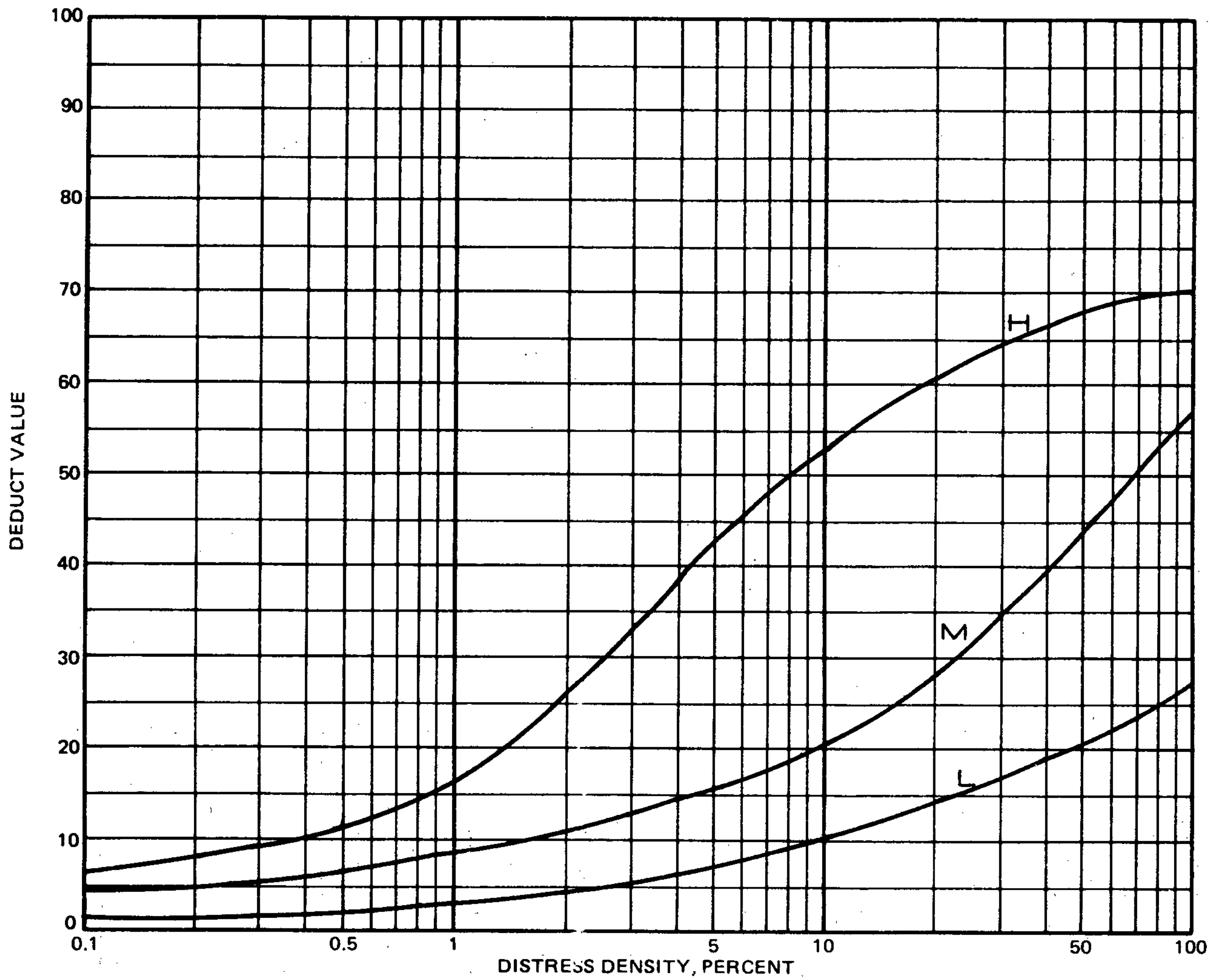


Figure A-40. Flexible pavement deduct values, distress 12, raveling/weathering

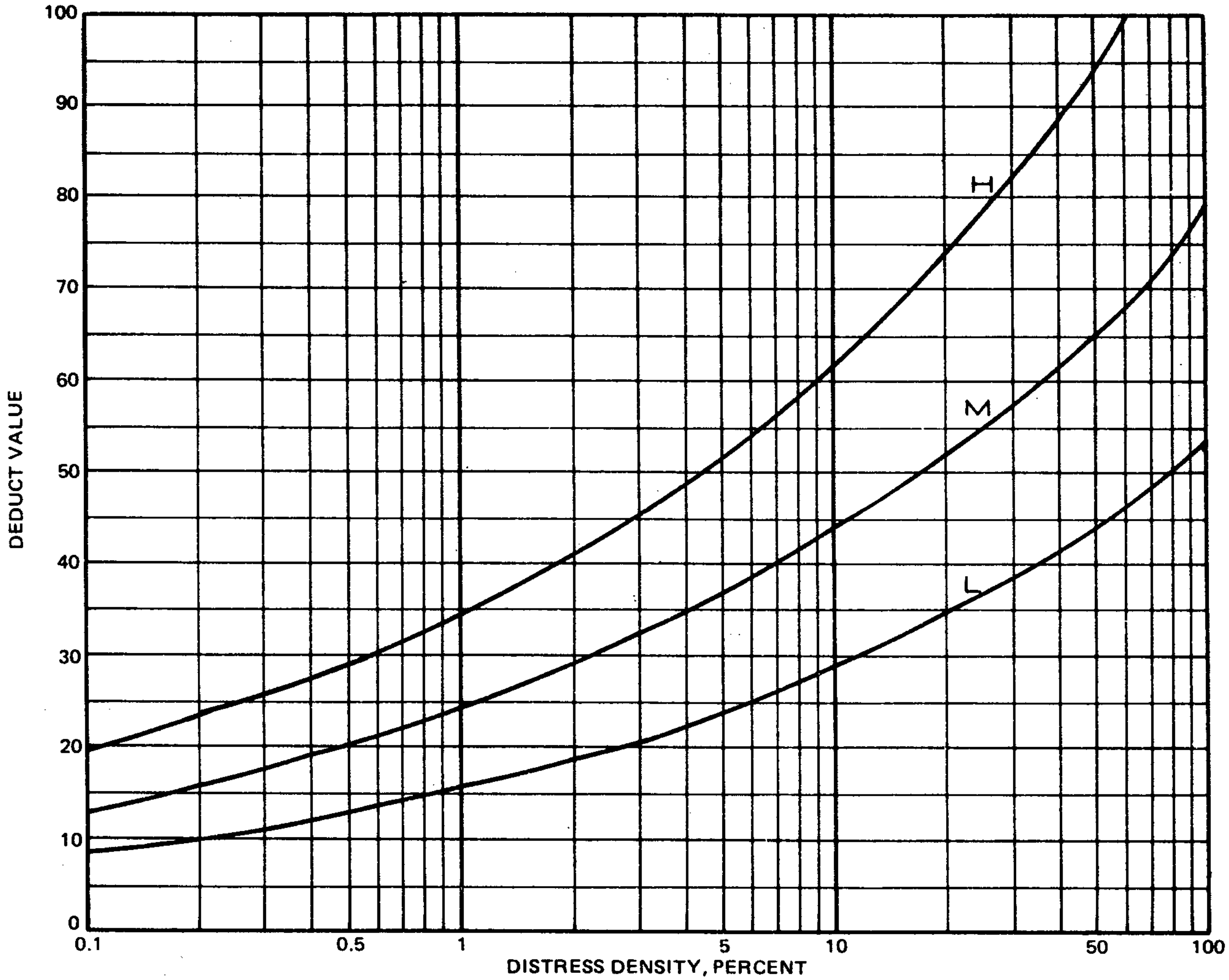


Figure A-41. Flexible pavement deduct values, distress 13, rutting

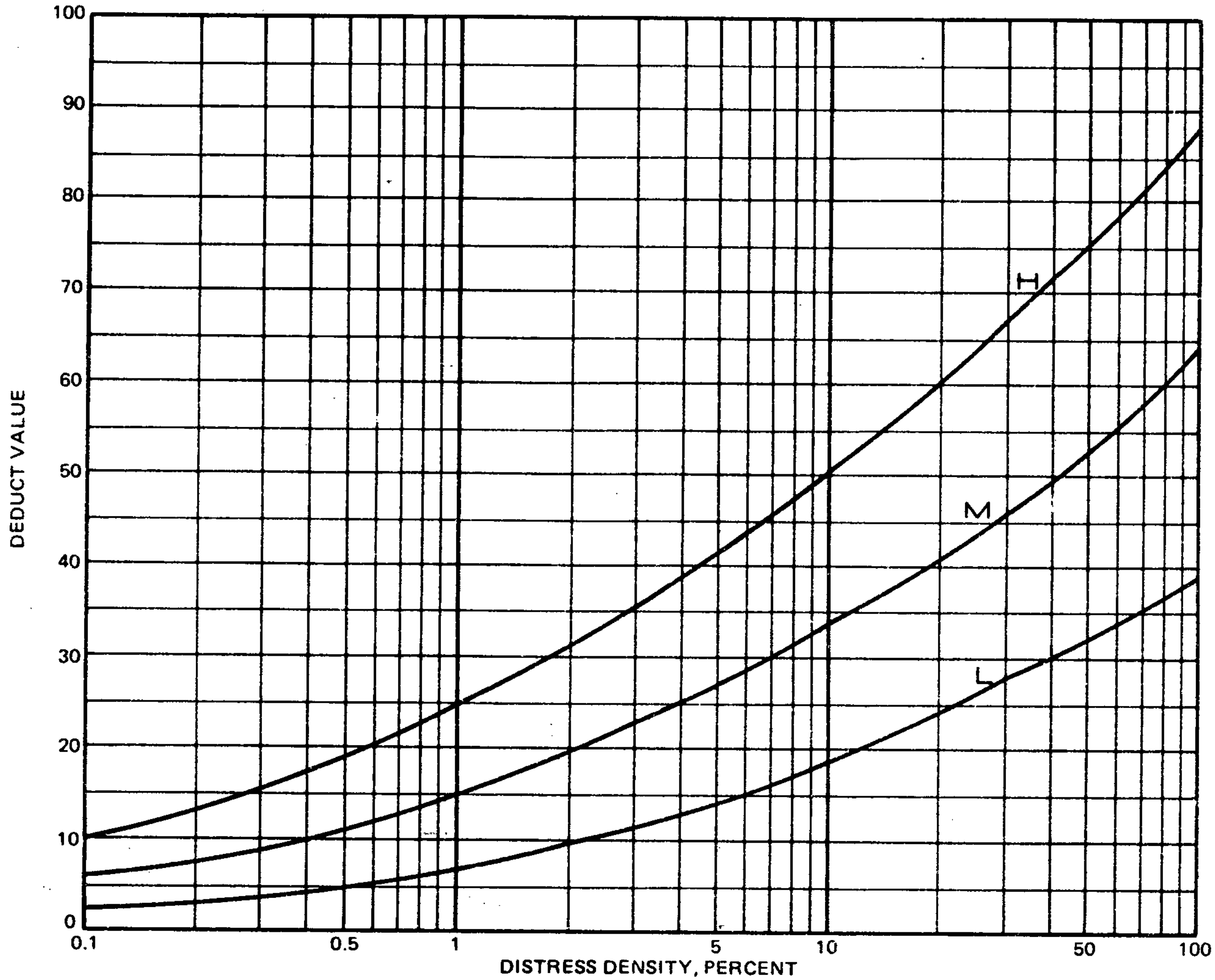


Figure A-42. Flexible pavement deduct values, distress 14, shoving of flexible pavement by PCC slabs

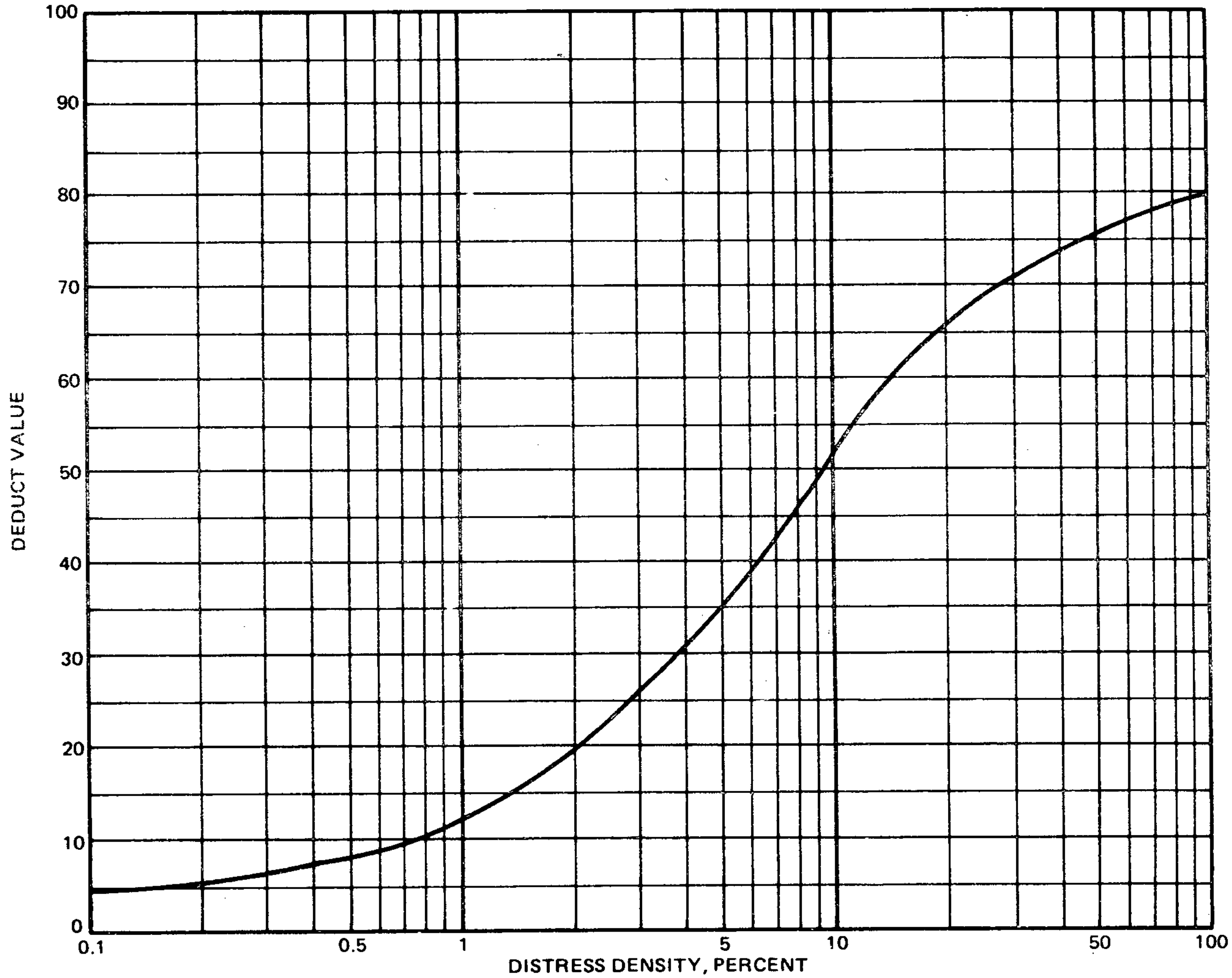


Figure A-43. Flexible pavement deduct values, distress 15, slippage cracking

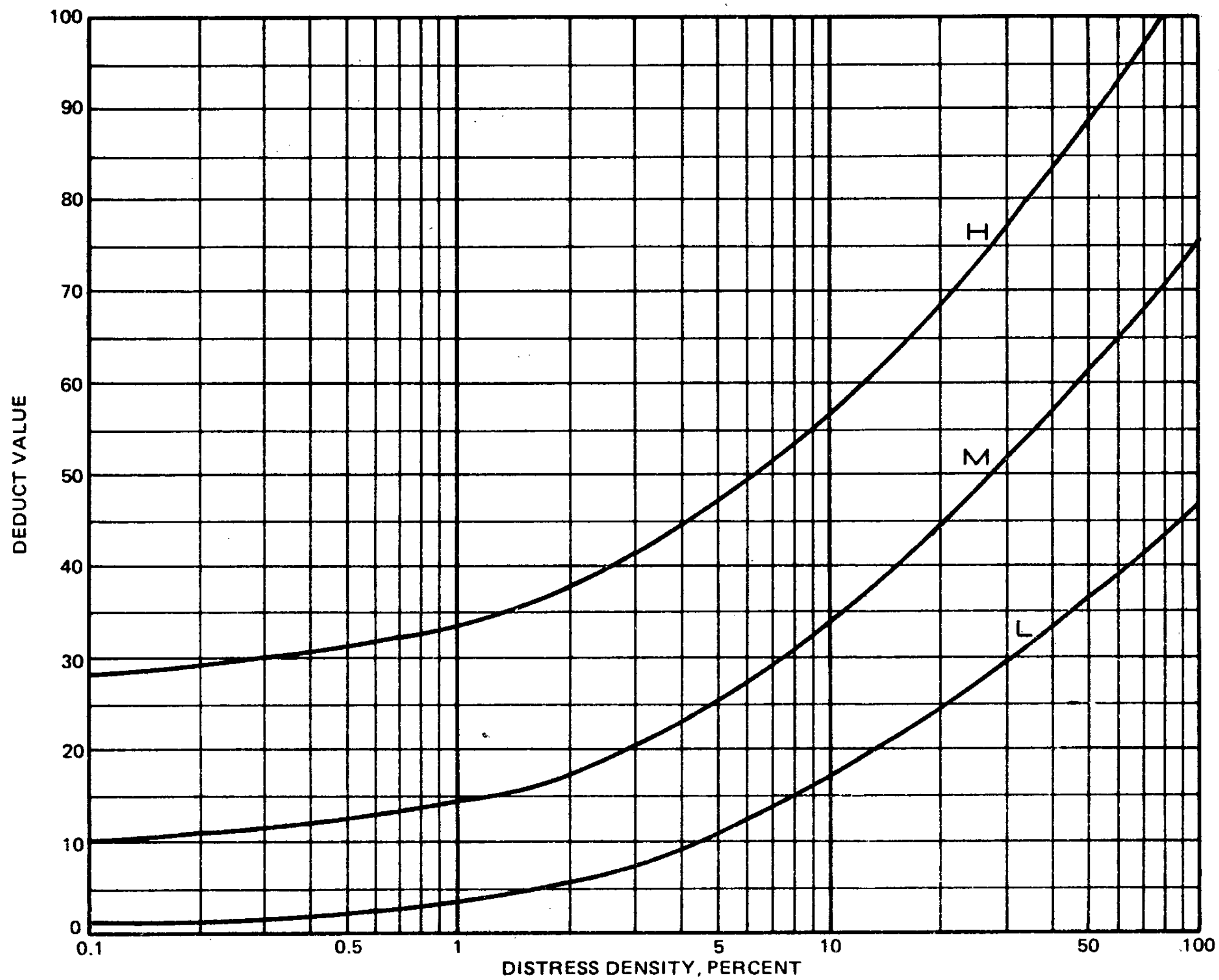


Figure A-44. Flexible pavement deduct values, distress 16, swell

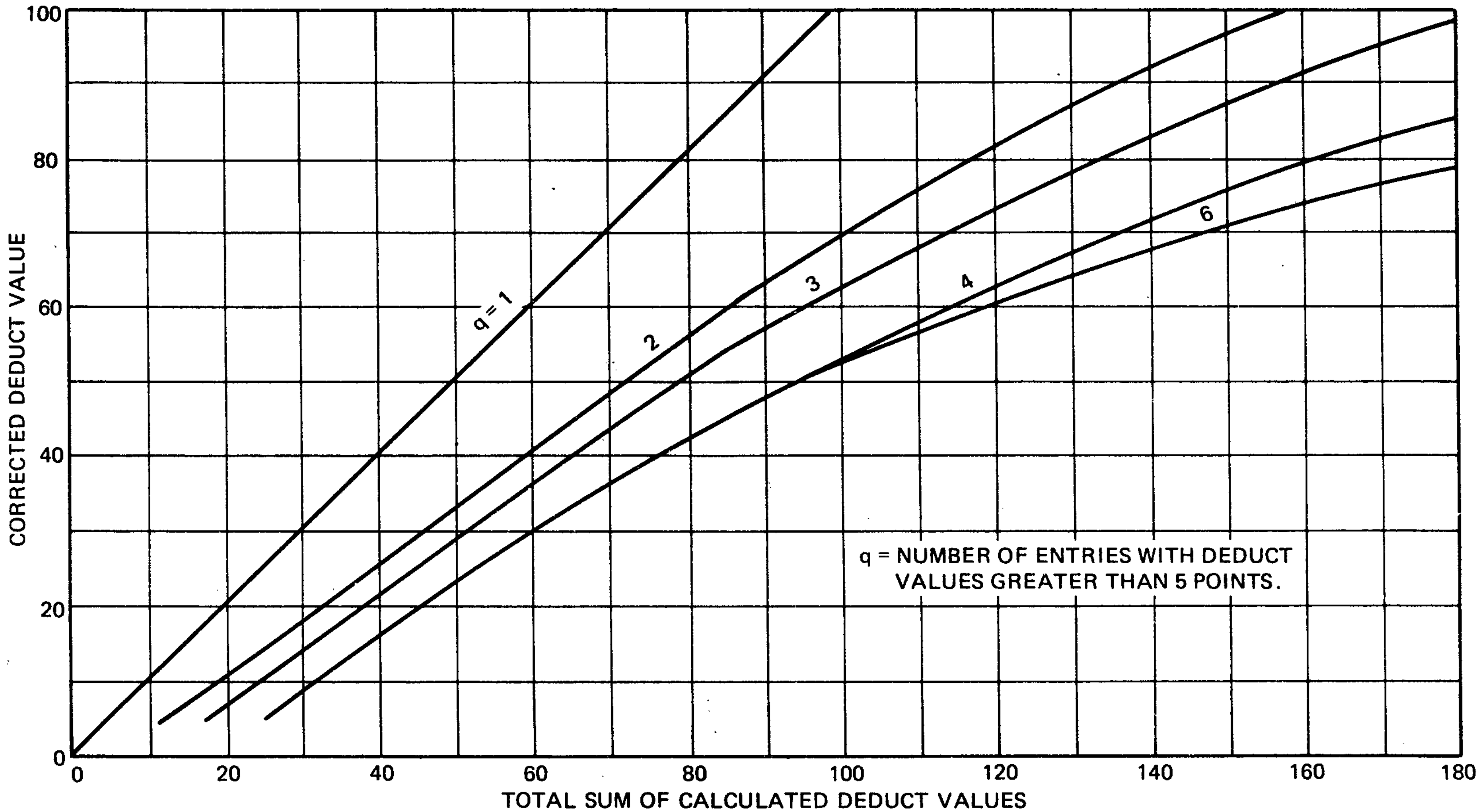


Figure A-45. Corrected deduct values for flexible pavements

Airport: World International

Airport Facility: Taxiway 5

Total No. of Sample Units: 25

Date of Survey: 26 March 1979

Sample Unit No.	Sample Unit Area, ft^2	PCI
1	5000	42
2	5000	33
3	5000	53
4	5000	39
5	5000	23
6	5000	25
7	5000	36
8	5000	38
9	5000	35
10	5000	25
11	5000	32
12	5000	45
13	5000	40
14	5000	55
15	5000	46

Sample Unit No.	Sample Unit Area, ft^2	PCI
16	5000	35
17	5000	22
18	5000	30
19	5000	39
20	5000	35
21	5000	32
22	5000	41
23	5000	49
24	5000	30
25	5000	22

Average PCI for Feature: 36

Condition Rating: Poor

Figure A-46. Feature summary for flexible pavements

APPENDIX B: AIRPORT PAVEMENT DISTRESS IDENTIFICATION MANUAL

OBJECTIVE

The objective of this manual is to provide pavement inspectors with a standardized reference for airport pavement distress identification. The distress information is to be used in conjunction with the procedures presented in the main text of this report to determine pavement condition and maintenance and repair requirements.

USE OF THE MANUAL

The types of airport pavement distress are listed alphabetically under the major categories of flexible pavements and jointed rigid pavements. Names, descriptions, severity levels, photographs, and measurement or count criteria presented for each distress were established based on the effect of the pavement's structural integrity, operational condition, and maintenance and repair requirements.

It is very important that the pavement inspector be able to identify all distress types and their severity levels. The inspector should study this manual prior to performing an inspection and should carry a copy for reference during the inspection.

It should be emphasized that pavement inspectors must follow the distress descriptions in this manual in order to arrive at meaningful and consistent PCI values.

Several items that are commonly encountered are outlined in Table B-1 for emphasis, and the rater should be aware of these frequently occurring items before starting the condition survey.

DISTRESSES IN FLEXIBLE PAVEMENTS

ALLIGATOR OR FATIGUE CRACKING - DISTRESS NO. 1

Description.

a. Alligator or fatigue cracking is a series of interconnecting cracks caused by fatigue failure of the asphaltic concrete (AC) surface under repeated traffic loading. The cracking initiates at the bottom of the AC surface (or stabilized

Table B-1

Frequently Occurring Identification Problems

in Pavement Distress Identification

Situation	Action	Remarks
	Distress in Flexible Pavements	
1. Alligator cracking and rutting in same area.	Record each separately at respective severity level.	
2. Bleeding has been counted in area.	Polished aggregate is not counted in same area.	
3. Polished aggregate in very small amount.	Do not count.	Polished aggregate is only counted when there is a significant amount.
4. Any distress (including cracking) in a patched area.	Do not record.	Effect of distress is considered in patch severity level.
5. For asphalt pavements if block cracking is recorded.	No longitudinal and transverse cracking should be recorded.	Does not apply to asphaltic concrete (AC) over portland cement concrete (PCC).
6. For asphalt overlay over concrete.	Block cracking, jointed reflection cracking, and longitudinal and transverse cracking reflected from old concrete is recorded separately.	AC over PCC could have, for example, 100 percent block cracking, 10 percent joint reflection cracking, and 1 percent longitudinal and transverse cracking.
	Distress in Jointed Rigid Pavements	
1. Low-severity scaling (i.e., crazing).	Count only if it is probable future scaling will occur within 2 to 3 years.	
2. Joint seal damage.	This is not counted on a slab-by-slab basis.	A severity level based on the overall condition of the joint seal in the sample unit is assigned.

(Continued)

Table B-1 (Concluded)

Situation	Action	Remarks
Distress in Jointed Rigid Pavements (Continued)		
3. Joint spall small enough to be filled during a joint seal repair.	Do not record.	
4. For a medium- or high-severity slab.	No other distress should be counted.	
5. Corner or joint spalling caused by "D" cracking.	Only "D" cracking should be recorded.	If spalls are caused by factors other than "D" cracking, record each factor separately.
6. Crack repaired by a narrow patch (e.g., 4 to 10 in. wide).	Record only crack and not patch at appropriate severity level.	
7. Original distress of patch is more severe than patch itself.	Original distress type should be recorded.	If, for example, patch material is present on scaled area of slab, only the scaling is counted.

base) where tensile stress and strain are highest under a wheel load. The cracks propagate to the surface initially as a series of parallel cracks. After repeated traffic loading, the cracks connect, forming many-sided, sharp-angled pieces that develop a pattern resembling chicken wire or the skin of an alligator. The pieces are less than 2 ft on the longest side.

b. Alligator cracking occurs only in areas that are subjected to repeated traffic loadings, such as wheel paths. Therefore, it would not occur over an entire area unless the entire area was subjected to traffic loading. Pattern-type cracking, which occurs over an entire area that is not subjected to loading, is rated as block cracking, which is not a load-associated distress.

c. Alligator cracking is considered a major structural distress.

Severity Levels.

a. Low severity level (L). Fine, longitudinal hairline cracks running parallel to one another with none or only a few interconnecting cracks. The cracks are not spalled (Figures B-1 through B-3).

b. Medium severity level (M). Further development of light alligator cracking into a pattern or network of cracks that may be lightly spalled (Figures B-4 through B-8).

c. High severity level (H). Network or pattern cracking has progressed so that the pieces are well defined and spalled at the edges; some of the pieces rock under traffic (Figure B-9).

Measuring Procedure. Alligator cracking is measured in square feet of surface area. The major difficulty in measuring this type of distress is that many times two or three levels of severity exist within one distressed area. If these portions can be easily distinguished from one another, they should be measured and recorded separately. However, if the different levels of severity cannot be easily divided, the entire area should be rated at the highest severity level present.

BLEEDING - DISTRESS NO. 2

Description. Bleeding is a film of bituminous material on the pavement surface that creates a shiny, glasslike, reflecting surface that usually becomes quite sticky. Bleeding is caused by excessive amounts of asphaltic cement or tars in the mix and/or low air void content. It occurs when asphalt fills the voids of the mix during hot

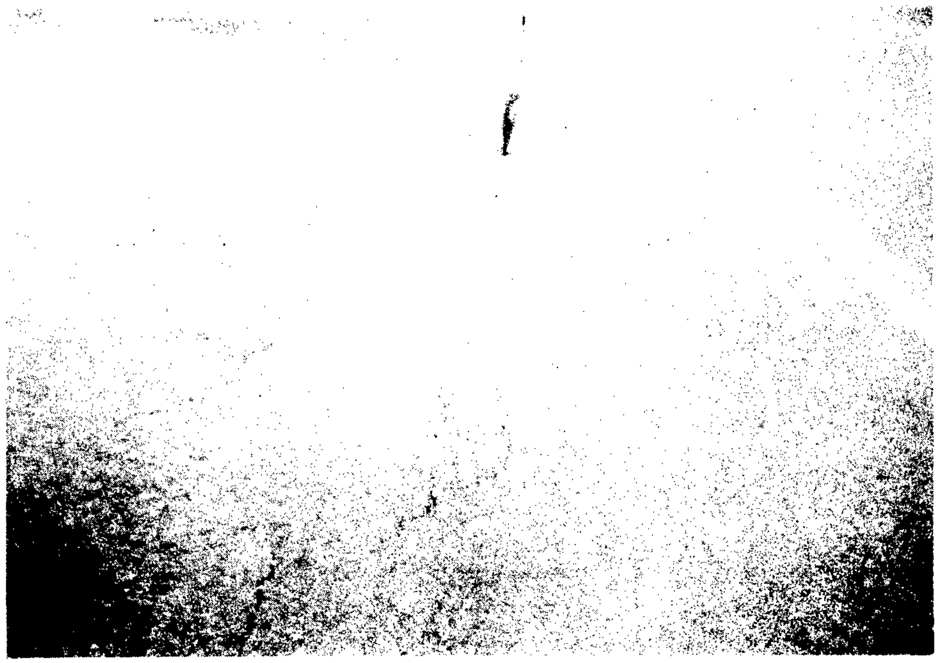


Figure B-1. Low severity alligator cracking, case 1

Figure B-2. Low severity alligator cracking, case 2

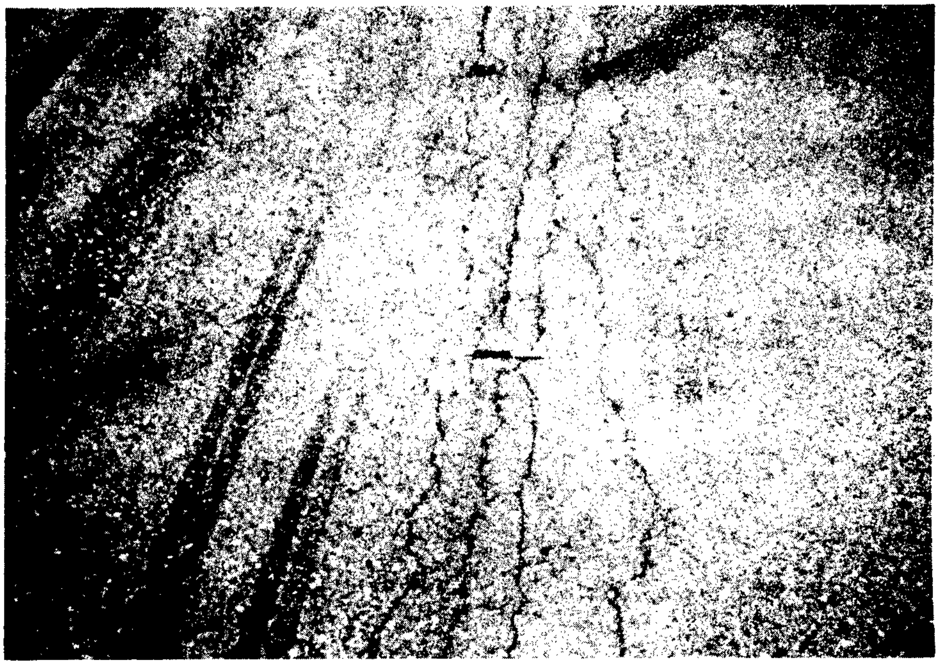


Figure B-3. Low severity alligator cracking, approaching medium severity

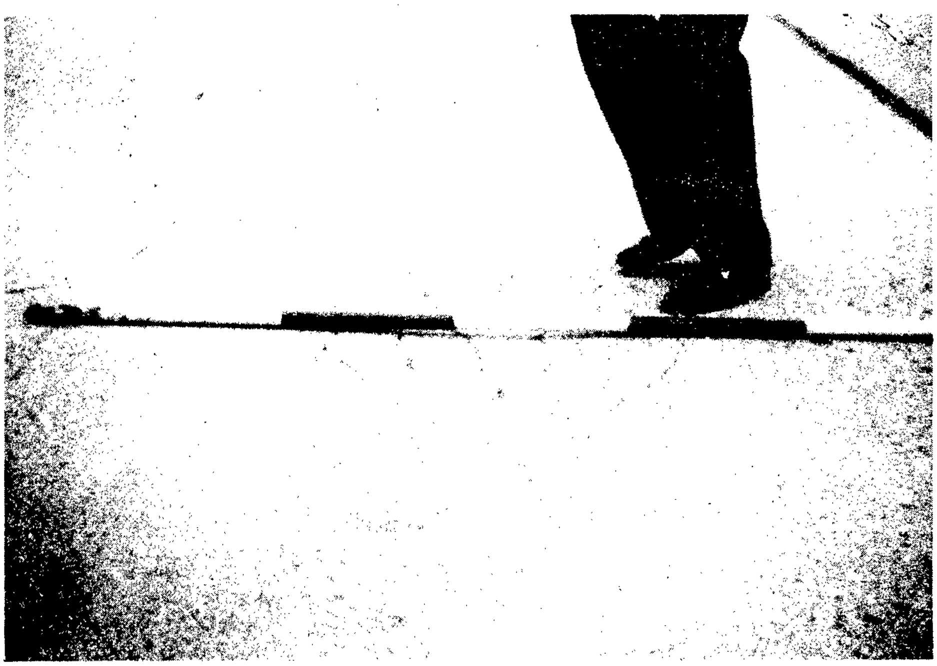


Figure B-4. Medium severity alligator cracking, case 1 (Note the depression occurring with the cracking.)

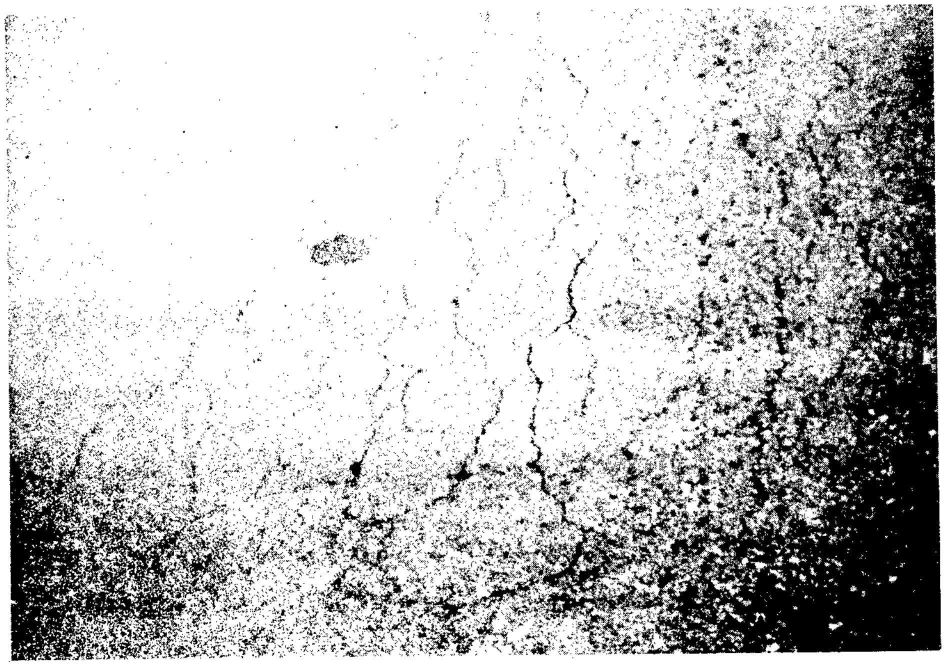


Figure B-5. Medium severity alligator cracking, case 2

Figure B-6. Medium severity alligator cracking, case 3

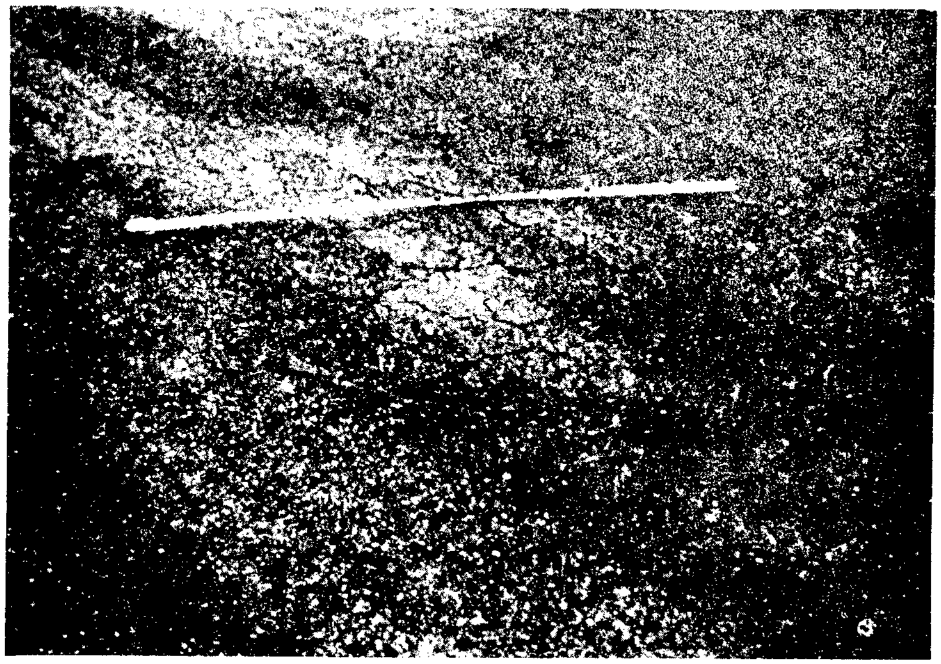


Figure B-7. Medium severity alligator cracking, approaching high severity, case 1

Figure B-8. Medium severity alligator cracking, approaching high severity, case 2

Figure B-9. High severity alligator cracking

weather and then expands out onto the surface of the pavement. Since the bleeding process is not reversible during cold weather, asphalt or tar will accumulate on the surface.

Severity Levels. No degrees of severity are defined. Bleeding should be noted when it is extensive enough to cause a reduction in skid resistance (Figures B-10 and B-11).

Measuring Procedure. Bleeding is measured in square feet of surface area.

BLOCK CRACKING - DISTRESS NO. 3

Description. Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. The blocks may range in size from approximately 1 by 1 ft to 10 by 10 ft. When the blocks are larger than 10 by 10 ft, they are classified as longitudinal or transverse cracking. Block cracking is caused mainly by shrinkage of the asphaltic concrete and daily temperature cycling (which results in daily stress/strain cycling). It is not load-associated. The occurrence of block cracking usually indicates that the asphalt has hardened

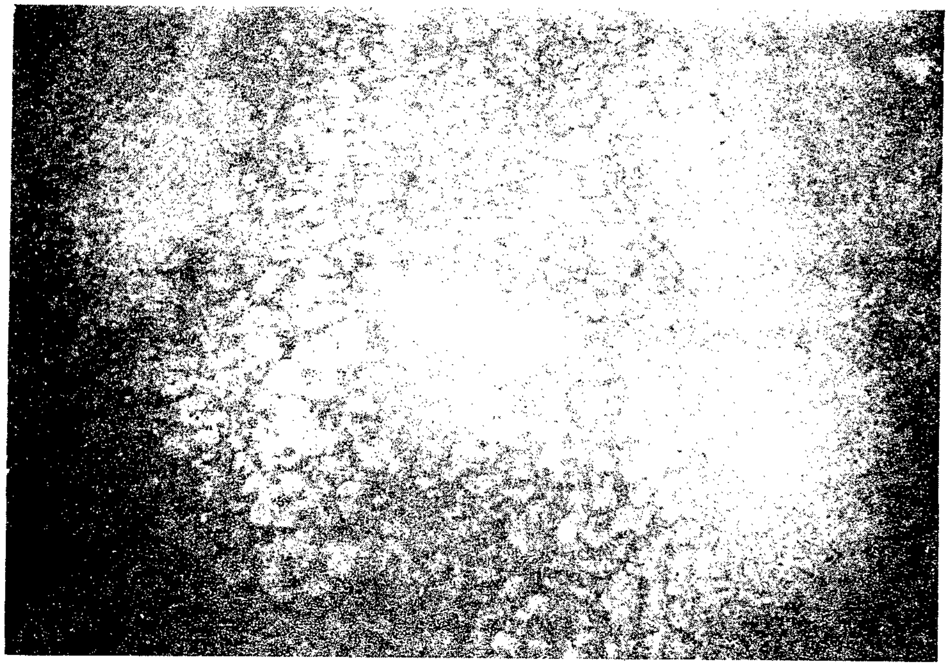


Figure B-10. Bleeding

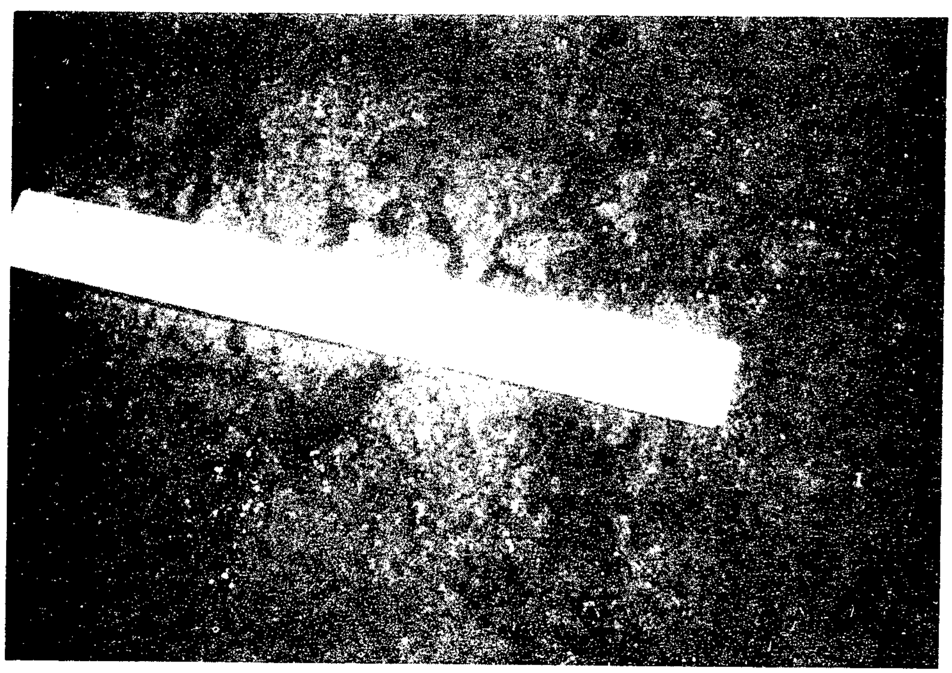


Figure B-11. Close-up of Figure B-10

significantly. Block cracking normally occurs over a large portion of pavement area, but sometimes will occur only in nontraffic areas. This type of distress differs from alligator cracking in that the alligator cracks form smaller, many-sided pieces with sharp angles. Also unlike block cracks, alligator cracks are caused by repeated traffic loadings and are, therefore, located only in traffic areas (i.e., wheel paths).

Severity Levels.

a. Low severity level (L). Blocks are defined by cracks that are nonspalled (sides of the crack are vertical) or only lightly spalled with no loose particles. Nonfilled cracks have 1/4 in. or less mean width, and filled cracks have a filler in satisfactory condition (Figures B-12 through B-15).

b. Medium severity level (M).

(1) Filled or nonfilled cracks that are moderately spalled with some loose particles.

(2) Nonfilled cracks that are not spalled or have only minor spalling with few loose particles but have a mean width greater than approximately 1/4 in.

(3) Filled cracks that are not spalled or have only minor spalling with a few loose particles, but have filler in unsatisfactory condition (Figures B-16 and B-17).

c. High severity level (H). Blocks are well defined by cracks that are severely spalled with loose and missing particles (Figures B-18 through B-20).

Measuring Procedure. Block cracking is measured in square feet of surface area, and usually occurs at one severity level in a given pavement section. Any areas of the pavement section having distinctly different levels of severity, however, should be measured and recorded separately.

CORRUGATION - DISTRESS NO. 4

Description. Corrugation is a series of closely spaced ridges and valleys (ripples) occurring at fairly regular intervals (usually less than 5 ft) along the pavement. The ridges are perpendicular to the traffic direction. Traffic action combined with an unstable pavement surface or base usually causes this type of distress.

Severity Levels.

a. Low severity level (L). Corrugations are minor and do not significantly affect ride quality (see measurement criteria below) (Figure B-21).

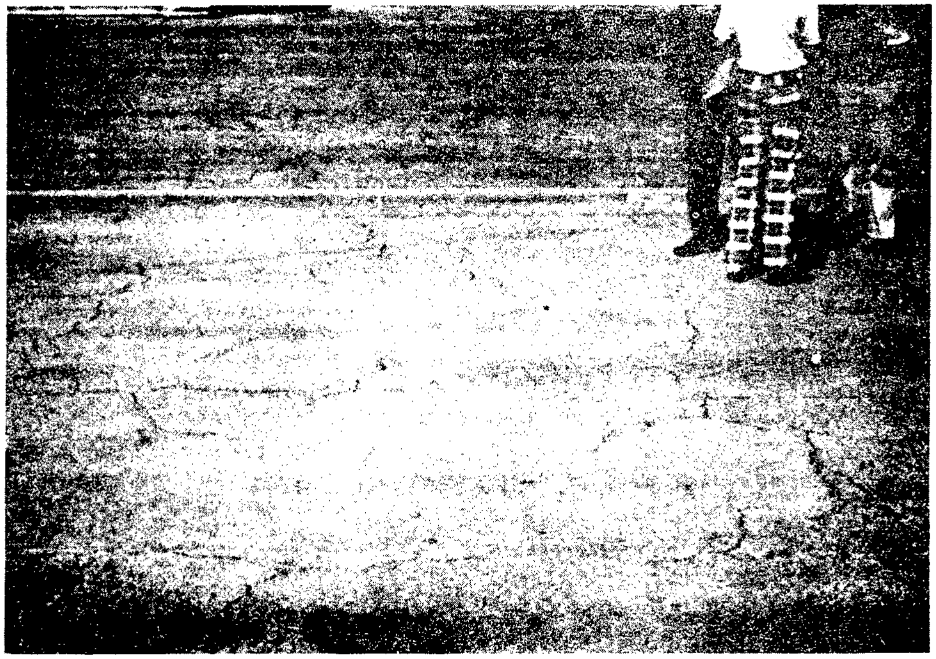


Figure B-12. Low severity block cracking

Figure B-13. Low severity block cracking, filled cracks, case 1

Figure B-14. Low severity block cracking, filled cracks, case 2

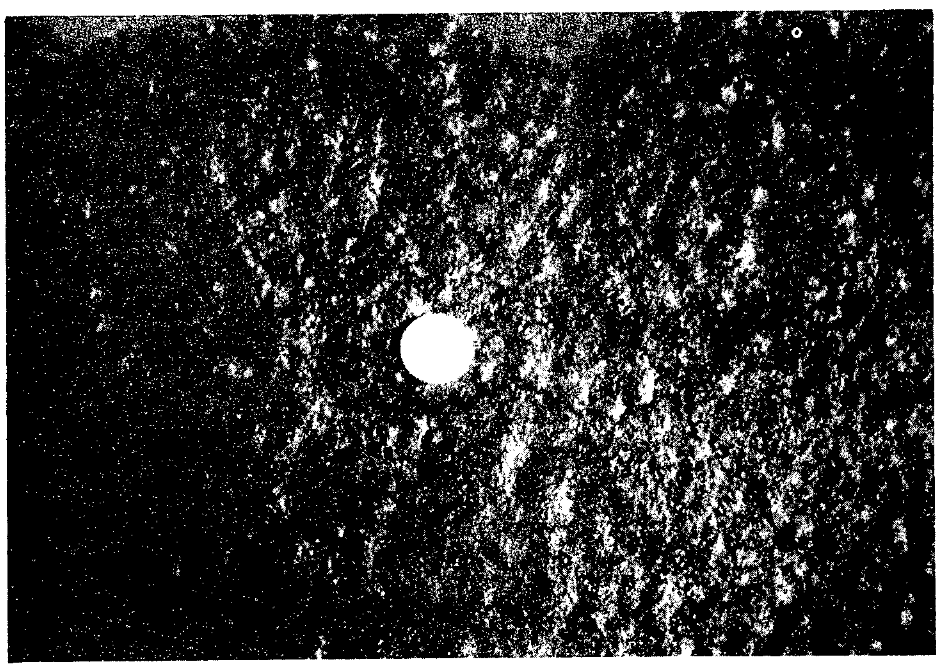


Figure B-15. Low severity block cracking, small blocks defined by hairline cracks

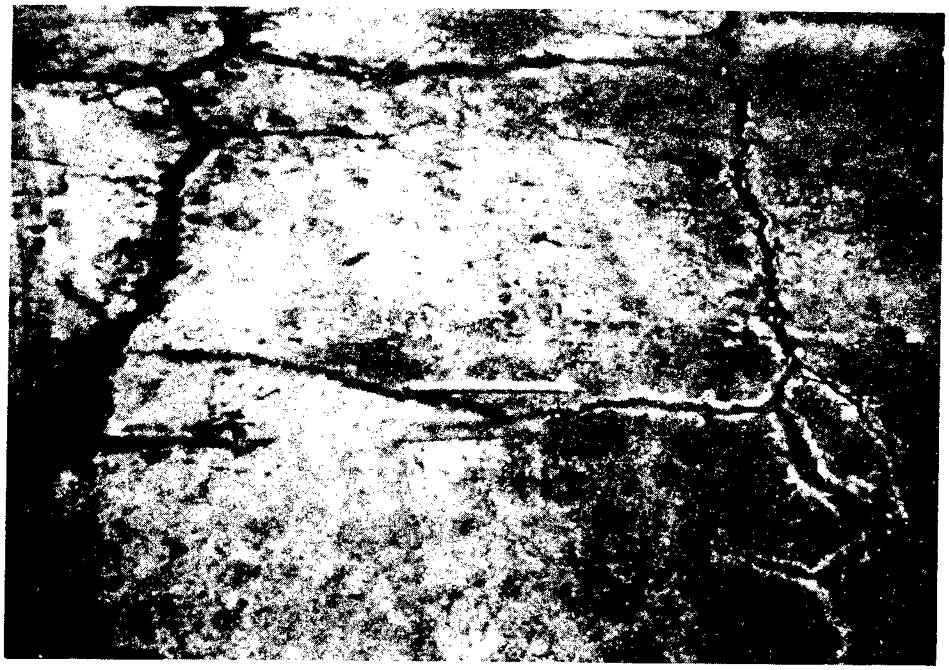


Figure B-16. Medium severity block cracking, case 1

Figure B-17. Medium severity block cracking, case 2

Figure B-18. High severity block cracking, case 1

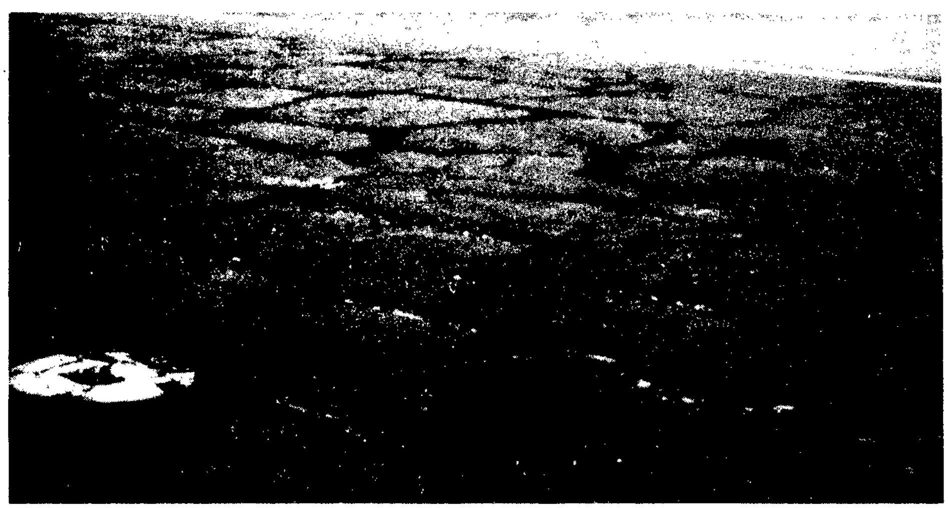


Figure B-19. High severity block cracking, case 2

Figure B-20. High severity block cracking, case 3

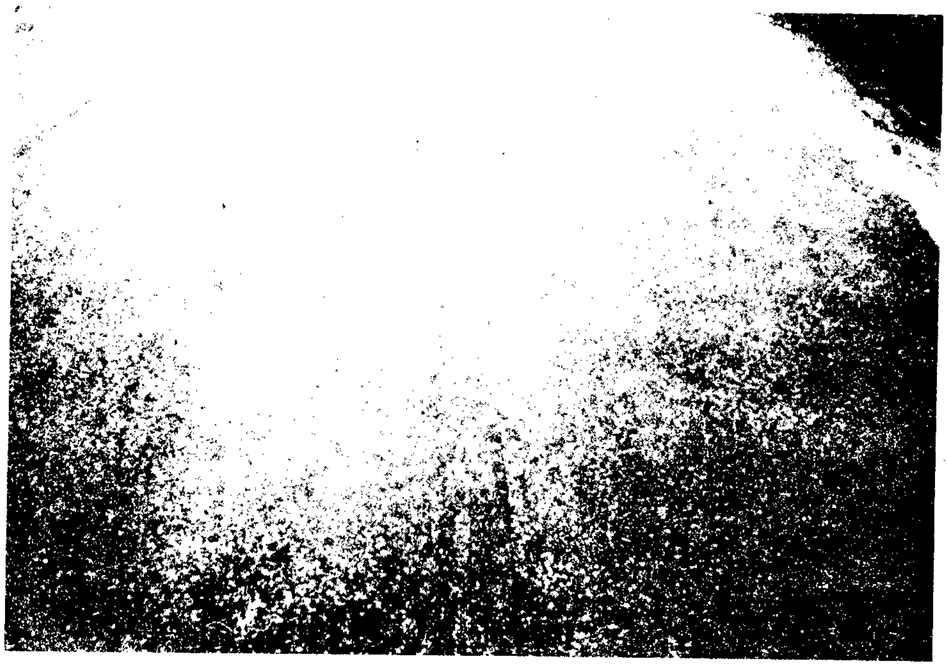


Figure B-21. Low severity corrugation in the foreground, changing to medium and high in the background

b. Medium severity level (M). Corrugations are noticeable and significantly affect ride quality (see measurement criteria below) (Figure B-22).

c. High severity level (H). Corrugations are easily noticed and severely affect ride quality (see measurement criteria below) (Figure B-23).

Measuring Procedure. Corrugation is measured in square feet of surface area. The mean elevation difference between the ridges and valleys of the corrugations indicates the level of severity. To determine the mean elevation difference, a 10-ft straightedge should be placed perpendicular to the corrugations so that the depth of the valleys can be measured in inches. The mean depth is calculated from five such measurements.

Severity	Runways and High-Speed Taxiways	Taxiways and Aprons
L	<1/4 in.	<1/2 in.
M	1/2-1/2 in.	1/2-1 in.
H	≥1/2 in.	≥1 in.

Some of the following photographs were taken on roads and streets. Corrugation is not commonly found on airport pavements.

DEPRESSION - DISTRESS NO. 5

Description. Depressions are localized pavement surface areas having elevations slightly lower than those of the surrounding pavement. In many instances, light depressions are not noticeable until after a rain, when ponding water creates "birdbath" areas; but the depressions can also be located without rain because of stains created by ponding of water. Depressions can be caused by settlement of the foundation soil or can be built during construction. Depressions cause roughness and, when filled with water of a sufficient depth, could cause hydroplaning of aircraft.

Severity Levels.

a. Low severity level (L). Depression can be observed or located by stained areas, only slightly affects pavement riding quality, and may cause hydroplaning potential on runways (see measurement criteria below) (Figure B-24).

Figure B-22. Medium severity corrugation

Figure B-23. High severity corrugation

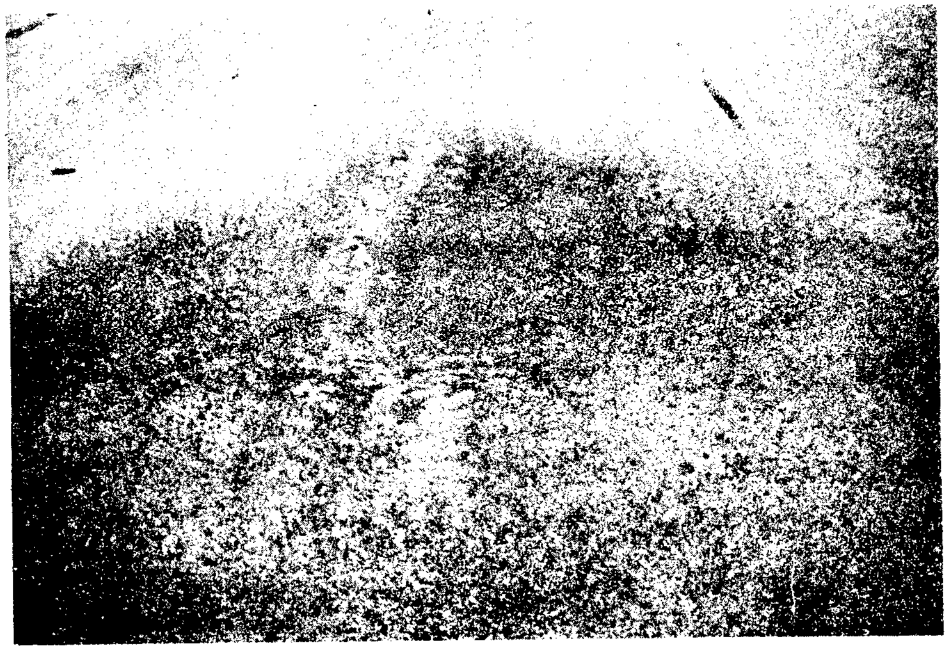


Figure B-24. Low severity depression

b. Medium severity level (M). The depression can be observed, moderately affects pavement riding quality, and causes hydroplaning potential on runways (see measurement criteria below) (Figures B-25 and B-26).

Figure B-25. Medium severity depression (>1/2 in.), case 1

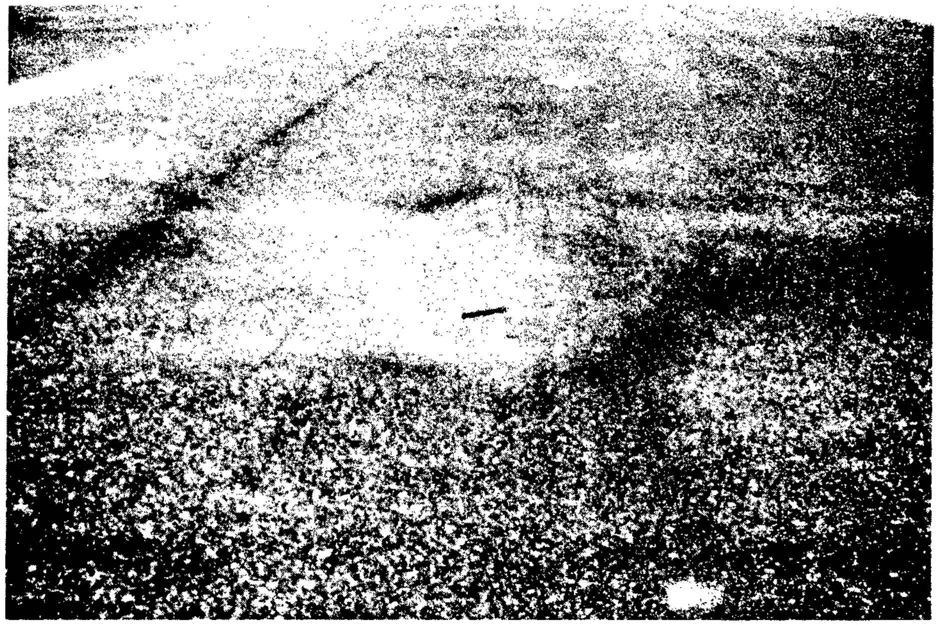


Figure B-26. Medium severity depression (> 1/2 in.), case 2

c. High severity level (H). The depression can be readily observed, severely affects pavement riding quality, and causes definite hydroplaning potential (see measurement criteria below) (Figure B-27).

Figure B-27. High severity depression (2 in.)

Measuring Procedure. Depressions are measured in square feet of surface area. The maximum depth of the depression determines the level of severity. This depth can be measured by placing a 10-ft straightedge across the depressed area and measuring the maximum depth in inches. Depressions larger than 10 ft across must be measured by either visual estimation or by direct measurement when filled with water.

Maximum Depth of Depression

Severity	Runways and High-Speed Taxiways	Taxiways and Aprons
L	1/8-1/2 in.	1/2-1 in.
M	1/2-1 in.	1-2 in.
H	> 1 in.	> 2 in.

JET BLAST EROSION - DISTRESS NO. 6

Description. Jet blast erosion causes darkened areas on the pavement surface where bituminous binder has been burned or carbonized. Localized burned areas may vary in depth up to approximately 1/2 in.

Severity Levels. No degrees of severity are defined. It is sufficient to indicate that jet blast erosion exists (Figures B-28 and B-29).

Measuring Procedure. Jet blast erosion is measured in square feet of surface area.

JOINT REFLECTION CRACKING FROM PCC (LONGITUDINAL AND TRANSVERSE) - DISTRESS NO. 7

Description. This distress occurs only on pavements having an asphalt or tar surface over a portland cement concrete (PCC) slab. This category does not include reflection cracking from any other type of base (i.e., cement stabilized, lime stabilized). Such cracks are listed as longitudinal and transverse cracks. Joint reflection cracking is caused mainly by movement of the PCC slab beneath the asphaltic concrete (AC) surface because of thermal and moisture changes. It is not load-related. However, traffic loading may cause a breakdown of the AC near

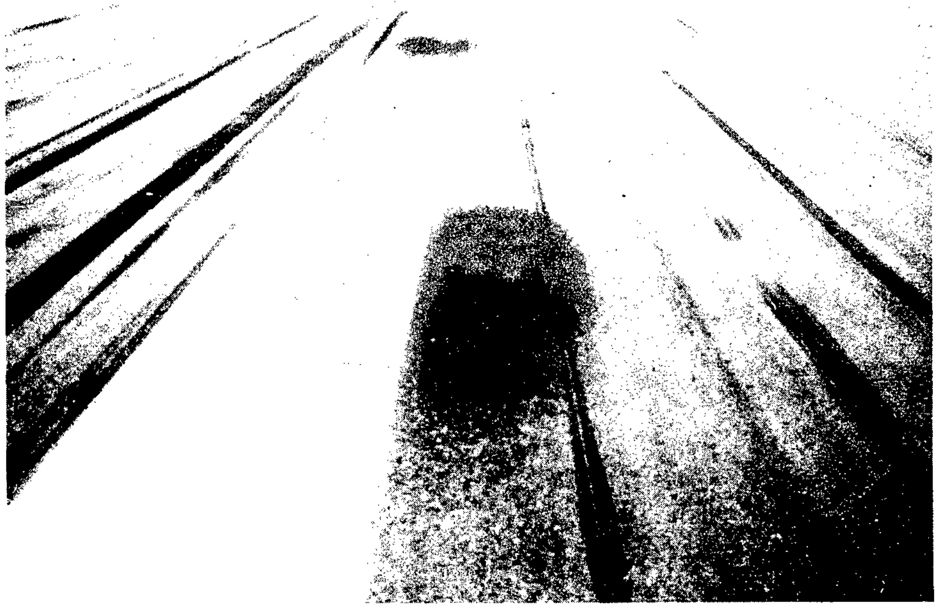


Figure B-28. Jet blast erosion, case 1

Figure B-29. Jet blast erosion, case 1

the crack, resulting in spalling. If the pavement is fragmented along a crack, the crack is said to be spalled. A knowledge of slab dimensions beneath the AC surface will help to identify these cracks.

Severity Levels.

a. Low severity level (L). Cracks have only little or no spalling and can be filled or nonfilled. If nonfilled, the cracks have a mean width of 1/4 in. or less. Filled cracks are of any width, but their filler material is in satisfactory condition (Figures B-30 through B-32).

b. Medium severity level (M). One of the following conditions exists:

(1) Cracks are moderately spalled with some loose particles and can be either filled or nonfilled and of any width.

(2) Filled cracks are not spalled or are only lightly spalled, but the filler is in unsatisfactory condition.

(3) Nonfilled cracks are not spalled or are only lightly spalled, but the mean crack width is greater than 1/4 in.

(4) Light random cracking exists near the crack or at the corners of intersecting cracks (Figures B-33 through B-35).

c. High severity level (H). Cracks are severely spalled with loose and missing particles and can be either filled or nonfilled and of any width (Figure B-36).

Measuring Procedure. Joint reflection cracking is measured in linear feet. The length and severity level of each crack should be identified and recorded. If the crack does not have the same severity level along its entire length, each portion should be recorded separately. For example, a crack that is 50 ft long may have 10 ft of a high severity crack, 20 ft of a medium severity, and 20 ft of a light severity. These would all be recorded separately.

LONGITUDINAL AND TRANSVERSE CRACKING (NON-PCC JOINT REFLECTIVE) - DISTRESS NO. 8

Description. Longitudinal cracks are parallel to the pavement's center line or laydown direction. They may be caused by (a) a poorly constructed paving lane joint, (b) shrinkage of the AC surface due to low temperatures or hardening of the asphalt, or (c) a reflective crack caused by cracks beneath the surface course, including cracks in PCC

Figure B-30. Low severity joint reflection cracking

Figure B-31. Low severity joint reflection cracking, filled crack

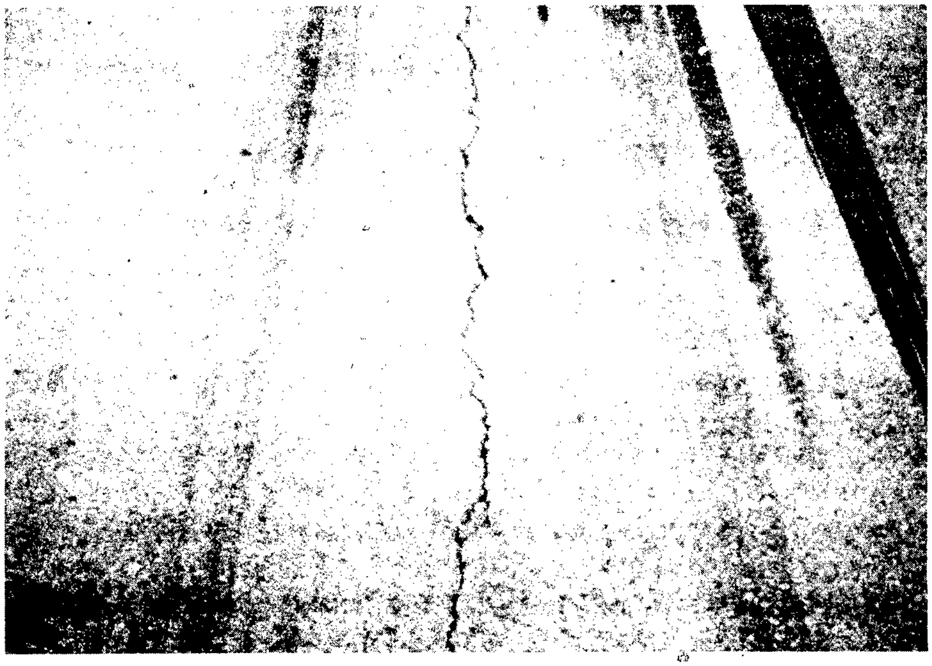


Figure B-32. Low severity joint reflection cracking, nonfilled crack

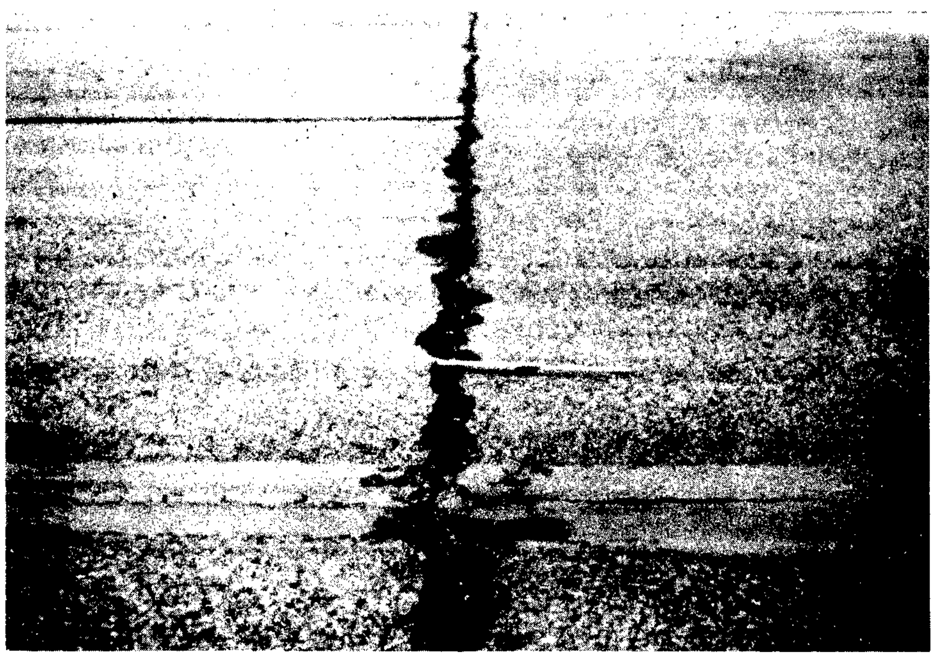


Figure B-33. Medium severity joint reflection cracking, case 1

Figure B-34. Medium severity joint reflection cracking, case 2

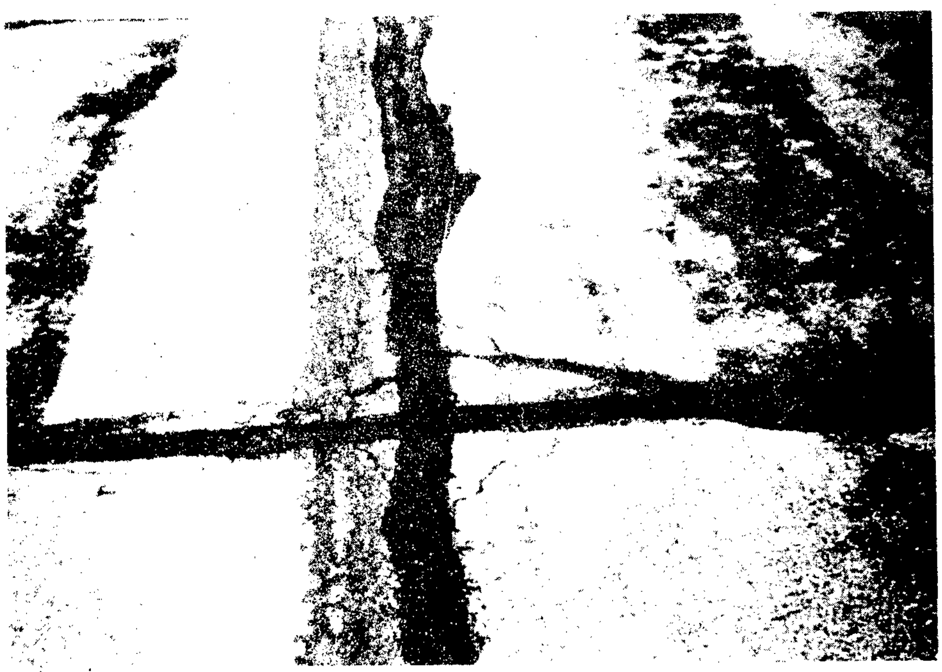


Figure B-35. Medium severity joint reflection cracking, case 3

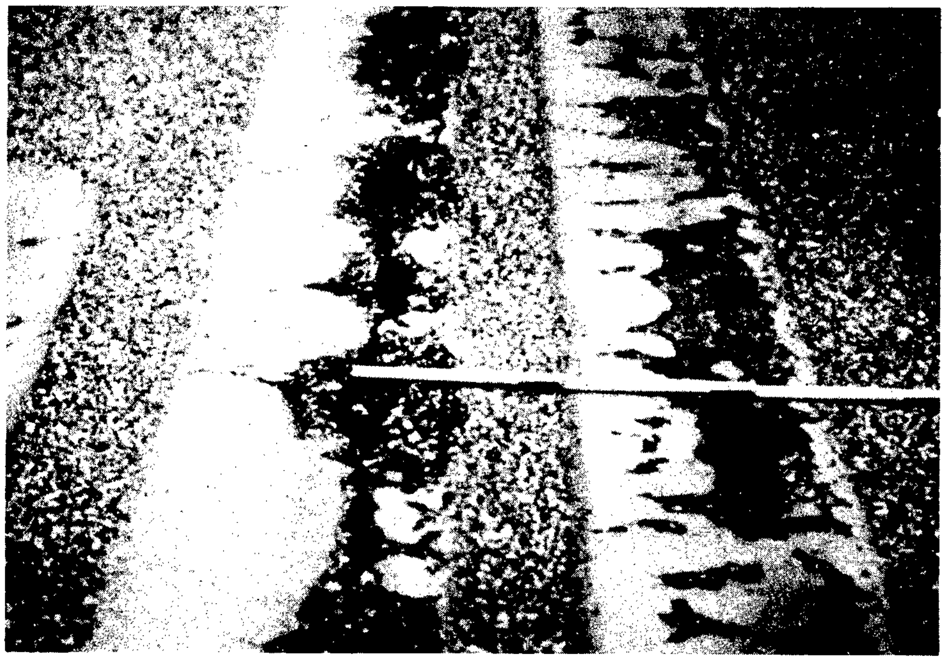


Figure B-36. High severity joint reflection cracking

slabs (but not at PCC joints). Transverse cracks extend across the pavement at approximately right angles to the pavement's center line or direction of laydown. They may be caused by items b or c above. These types of cracks are not usually load-associated. If the pavement is fragmented along cracks, the crack is said to be spalled.

Severity Levels.

a. Low severity level (L). Cracks have either little or no spalling with no loose particles. The cracks can be filled or nonfilled. Nonfilled cracks have a mean width of 1/4 in. or less. Filled cracks are of any width, but their filler material is in satisfactory condition (Figures B-37 and B-38).

b. Medium severity level (M). One of the following conditions exists:

(1) Cracks are moderately spalled with few loose particles and can be either filled or nonfilled of any width.

(2) Filled cracks are not spalled or are only lightly spalled, but the filler is in unsatisfactory condition.

(3) Nonfilled cracks are not spalled or are only lightly spalled, but mean crack width is greater than 1/4 in.

(4) Light random cracking exists near the crack or at the corners of intersecting cracks (Figures B-39 through B-41).

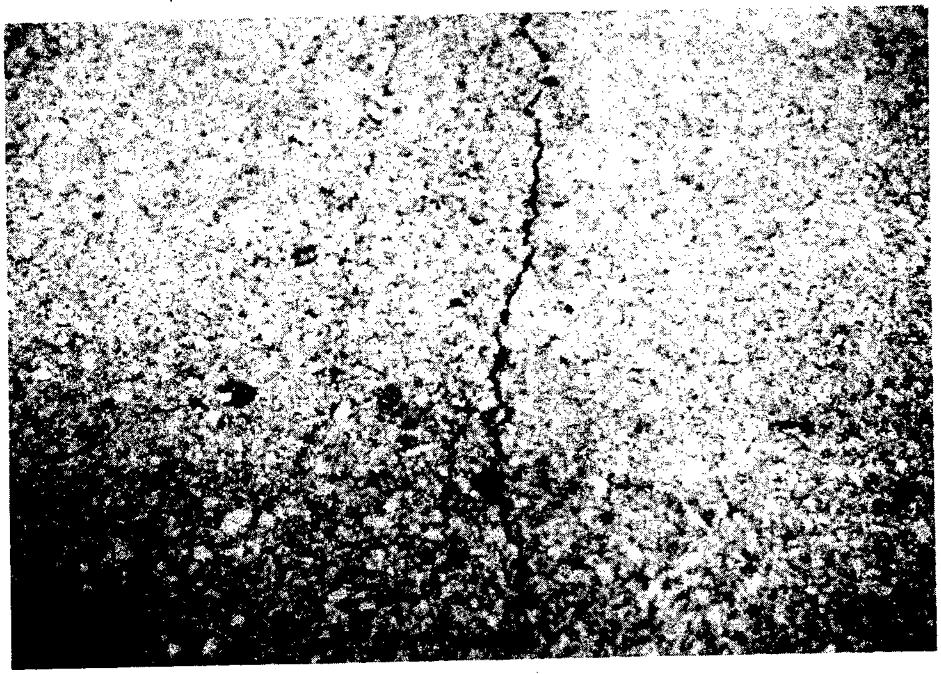


Figure B-37. Low severity longitudinal crack, flexible pavement

Figure B-38. Low severity longitudinal cracks, approaching medium, flexible pavement

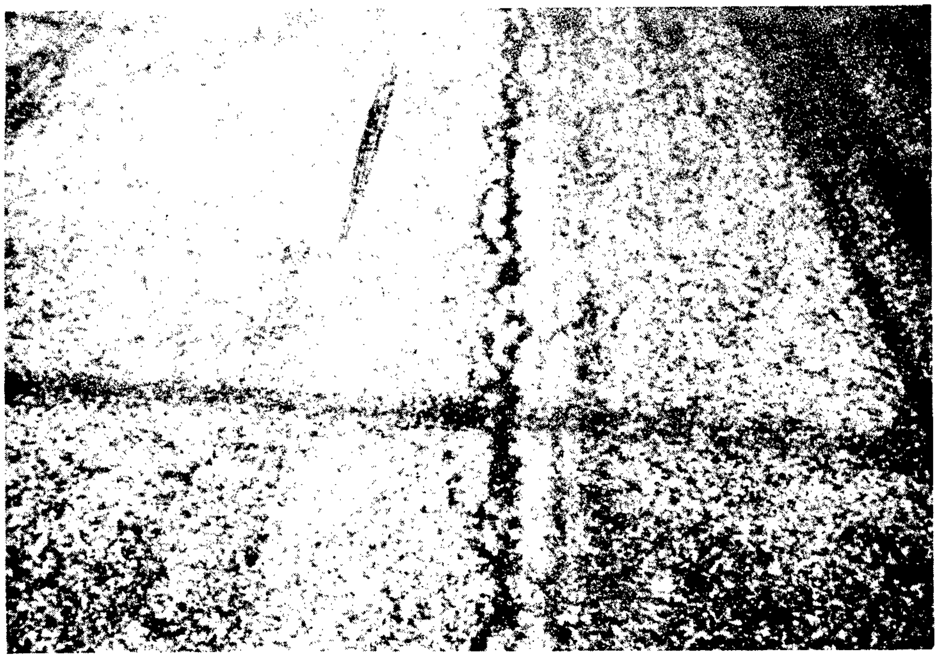


Figure B-39. Medium severity longitudinal construction joint crack, flexible pavement, case 1

Figure B-40. Medium severity longitudinal crack, flexible pavement, case 2 (Note the crack is reflective but not at the joint of slab.)

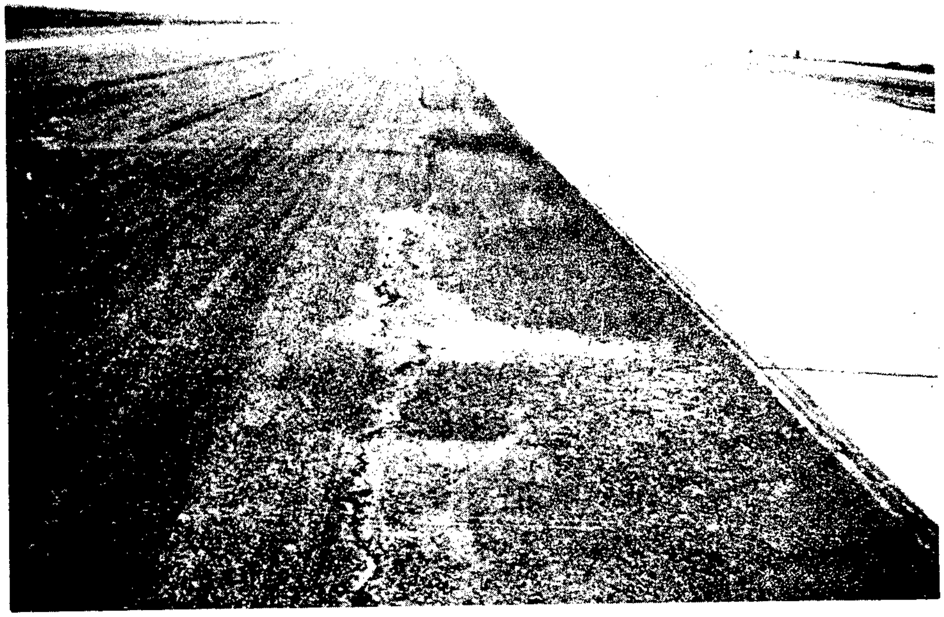


Figure B-41. Medium severity longitudinal crack, flexible pavement, case 3

c. <u>High severity level (H)</u>. Cracks are severely spalled with loose and missing particles. They can be either filled or non-filled of any width (Figure B-42).

Figure B-42. High severity longitudinal crack, flexible pavement

Measuring Procedure. Longitudinal and transverse cracks are measured in linear feet. The length and severity of each crack should be identified and recorded. If the crack does not have the same severity level along its entire length, each portion of the crack having a different severity level should be recorded separately. For an example see joint reflection cracking.

OIL SPILLAGE - DISTRESS NO. 9

Description. Oil spillage is the deterioration or softening of the pavement surface caused by the spilling of oil, fuel, or other solvents (Figures B-43 and B-44).

Severity Levels. No degrees of severity are defined. It is sufficient to indicate that oil spillage exists.

Measuring Procedure. Oil spillage is measured in square feet of surface area.

PATCHING AND UTILITY CUT
PATCH - DISTRESS NO. 10

Description. A patch is considered a defect, no matter how well it is performing.

Severity Levels.

a. Low severity level (L). Patch is in good condition and is performing satisfactorily (Figures B-45 through B-47).

b. Medium severity level (M). Patch is somewhat deteriorated and affects riding quality to some extent (Figure B-48).

c. High severity level (H). Patch is badly deteriorated and affects ride quality significantly. Patch soon needs replacement (Figure B-49).

Measuring Procedure. Patching is measured in square feet of surface area. However, if a single patch has areas of differing severity levels, these areas should be measured and recorded separately. For example, a 25-sq-ft patch may have 10 sq ft of medium severity and 15 sq ft of light severity. These areas would be recorded separately.

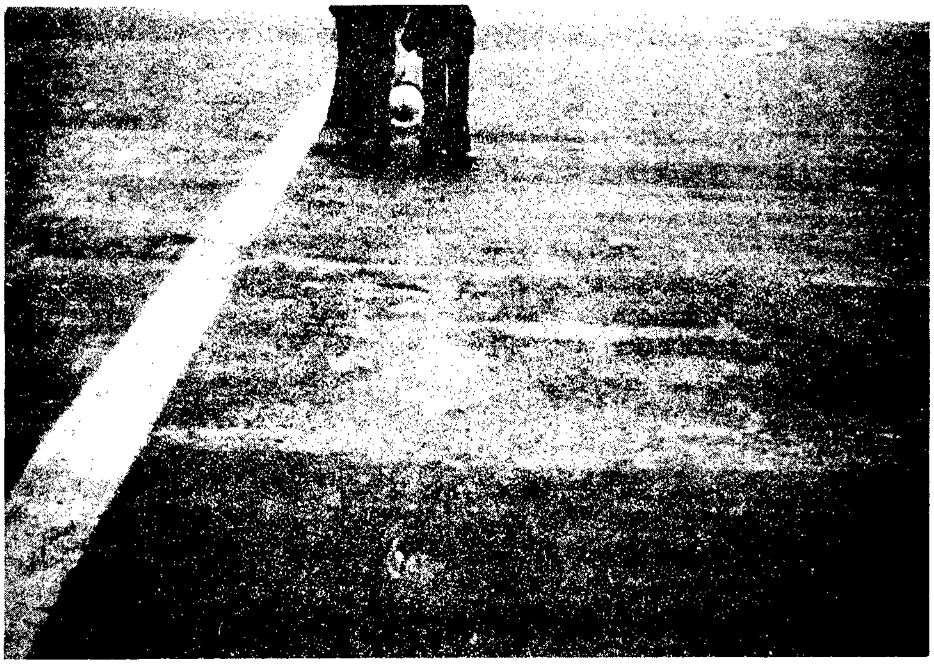


Figure B-43. Oil spillage, case 1

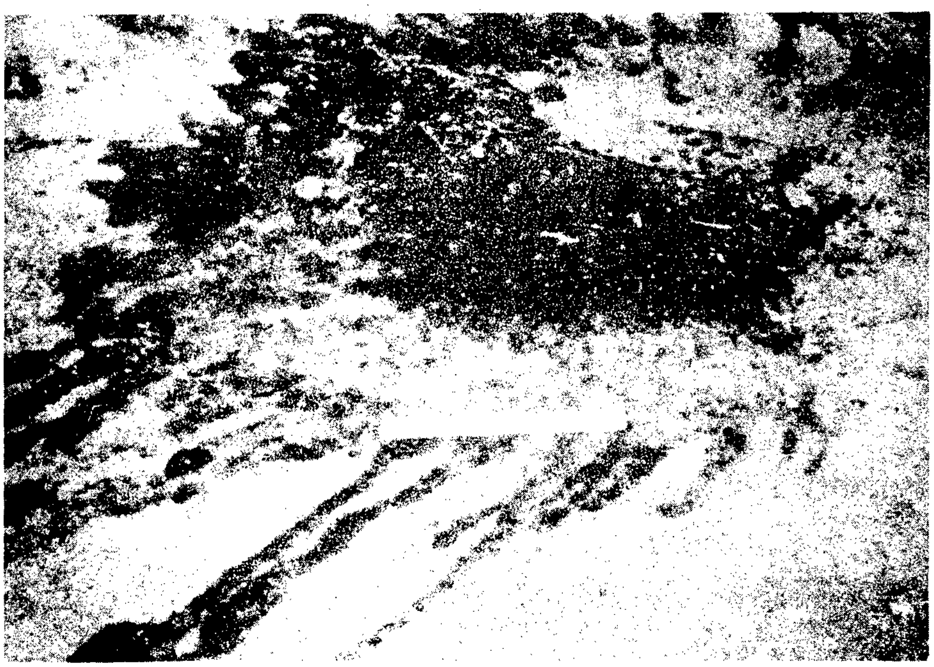


Figure B-44. Oil spillage, case 2

Figure B-45. Light severity patch, flexible pavement, case 1

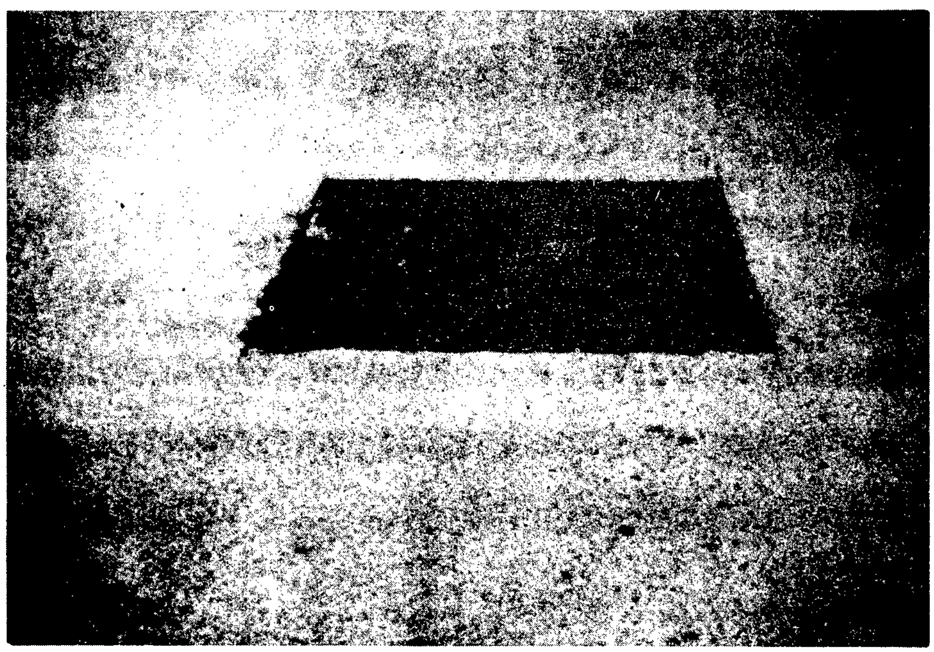


Figure B-46. Light severity patch, flexible pavement, case 2

Figure B-47. Light severity patch with medium severity portion, flexible pavement

Figure B-48. Medium severity patch, flexible pavement

Figure B-49. High severity patch, flexible pavement

POLISHED AGGREGATE -
DISTRESS NO. 11

Description. Aggregate polishing is caused by repeated traffic applications. Polished aggregate is present when close examination of a pavement reveals that the portion of aggregate extending above the asphalt is either very small, or there are no rough or angular aggregate particles to provide good skid resistance.

Severity Levels. No degrees of severity are defined. However, the degree of polishing should be significant before it is included in the condition survey and rated as a defect (Figure B-50).

Measuring Procedure. Polished aggregate is measured in square feet of surface area.

RAVELING AND WEATHERING -
DISTRESS NO. 12

Description. Raveling and weathering are the wearing away of the pavement surface caused by the dislodging of aggregate particles and loss of asphalt or tar binder. They may indicate that the asphalt binder has hardened significantly.

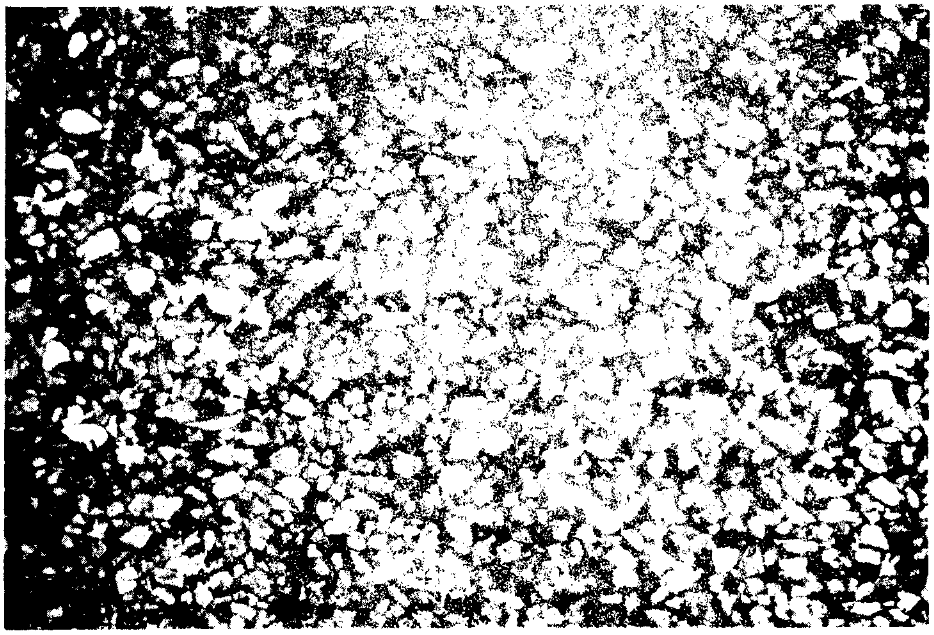


Figure B-50. Polished aggregate

Severity Levels.

a. Low severity level (L). Aggregate or binder has started to wear away with few, if any, loose particles (Figures B-51 through B-53).

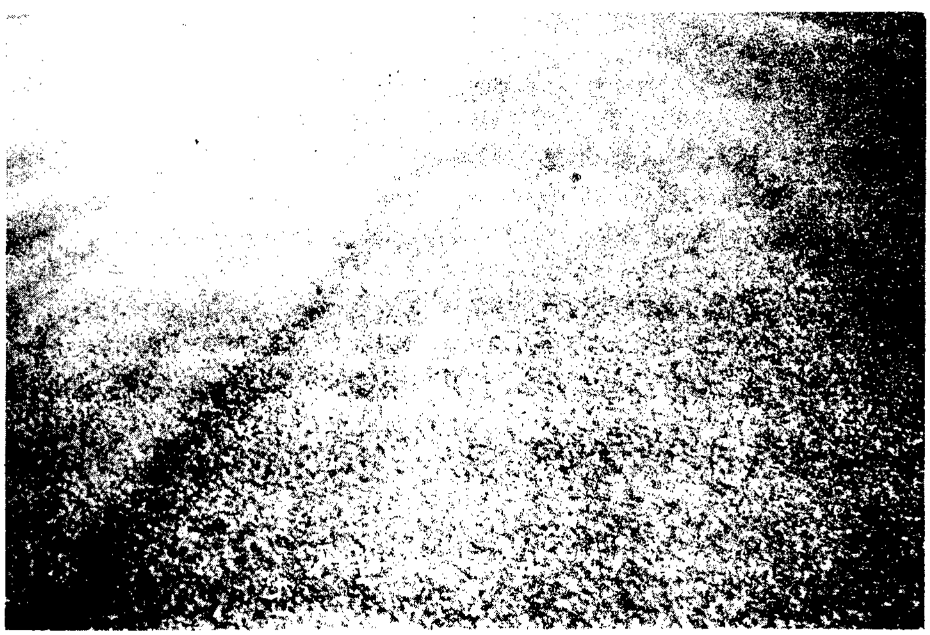


Figure B-51. Light severity raveling/weathering, case 1

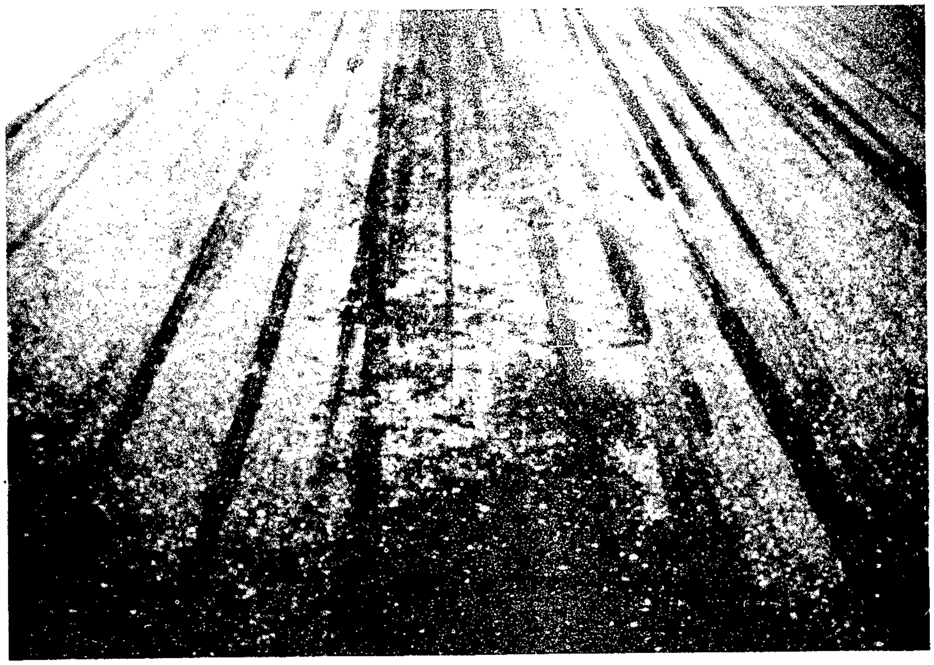


Figure B-52. Light severity raveling/weathering, case 2

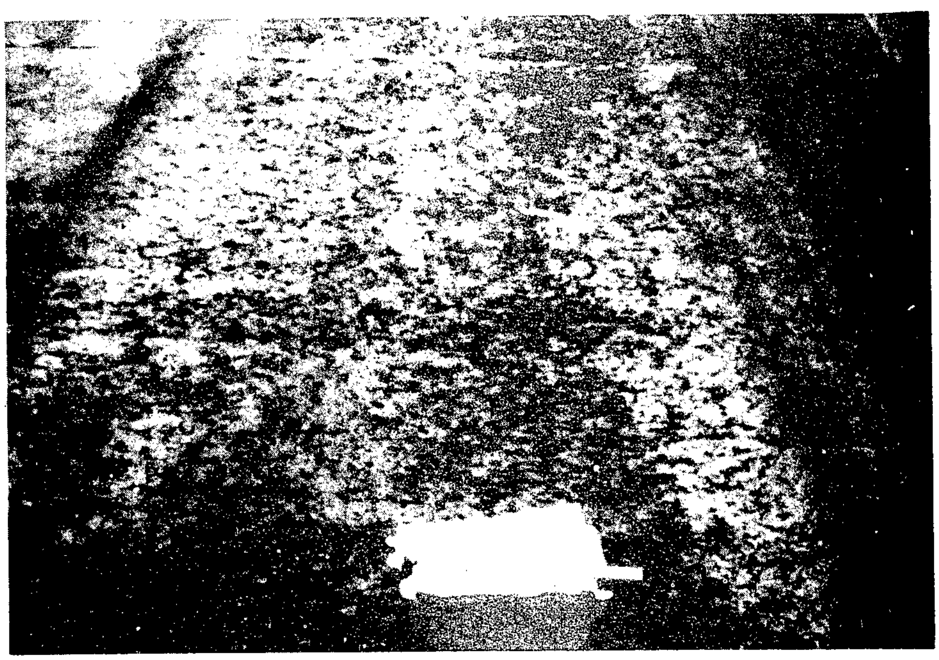


Figure B-53. Light severity raveling/weathering, approaching medium severity

b. Medium severity level (M). Aggregate and/or binder has worn away with some loose and missing particles. The surface texture is moderately rough and pitted (Figure B-54).

Figure B-54. Medium severity raveling/weathering

c. High severity level (H). Aggregate and/or binder has worn away with a large amount of loose and missing particles. The surface texture is severely rough and pitted (Figures B-55 and B-56).

Measuring Procedure. Raveling and weathering are measured in square feet of surface area.

RUTTING - DISTRESS NO. 13

Description. A rut is a surface depression in the wheel path. Pavement uplift may occur along the sides of the rut; however, in many instances ruts are noticeable only after a rainfall, when the wheel paths are filled with water. Rutting stems from a permanent deformation in any of the pavement layers or subgrade, usually caused by consolidation

Figure B-55. High severity raveling/weathering, case 1

Figure B-56. High severity raveling/weathering, case 2 or lateral movement of the materials due to traffic loads. Significant rutting can lead to major structural failure of the pavement.

Severity Levels.

Mean Rut Depth Criteria

Severity	All Pavement Sections
L	1/4-1/2 in. (Figures B-57 and B-58)
M	>1/2-1 in. (Figure B-59)
H	>1 in. (Figures B-60 and B-61)

Measuring Procedure. Rutting is measured in square feet of surface area, and its severity is determined by the mean depth of the rut. To determine the mean rut depth, a straightedge should be laid across the rut and the depth measured. The mean depth in inches should be computed from measurements taken along the length of the rut.

SHOVING OF ASPHALT PAVEMENT
BY PCC SLABS - DISTRESS NO. 14

Description. PCC pavements occasionally increase in length at ends where they adjoin flexible pavements (commonly referred to as "pavement growth"). This "growth" shoves the asphalt- or tar-surfaced pavements, causing them to swell and crack. The PCC slab "growth" is caused by a gradual opening up of the joints as they are filled with incompressible materials that prevent them from reclosing.

Severity Level.

a. Low severity level (L). A slight amount of shoving has occurred with little effect on ride quality and no breakup of the asphalt pavement (Figure B-62).

b. Medium severity level (M). A significant amount of shoving has occurred, causing moderate roughness and little or no breakup of the asphalt pavement (Figure B-62).

c. High severity level (H). A large amount of shoving has occurred, causing severe roughness or breakup of the asphalt pavement (Figure B-63).

Measuring Procedure. Shoving is measured by determining the area in square feet of the swell caused by shoving.

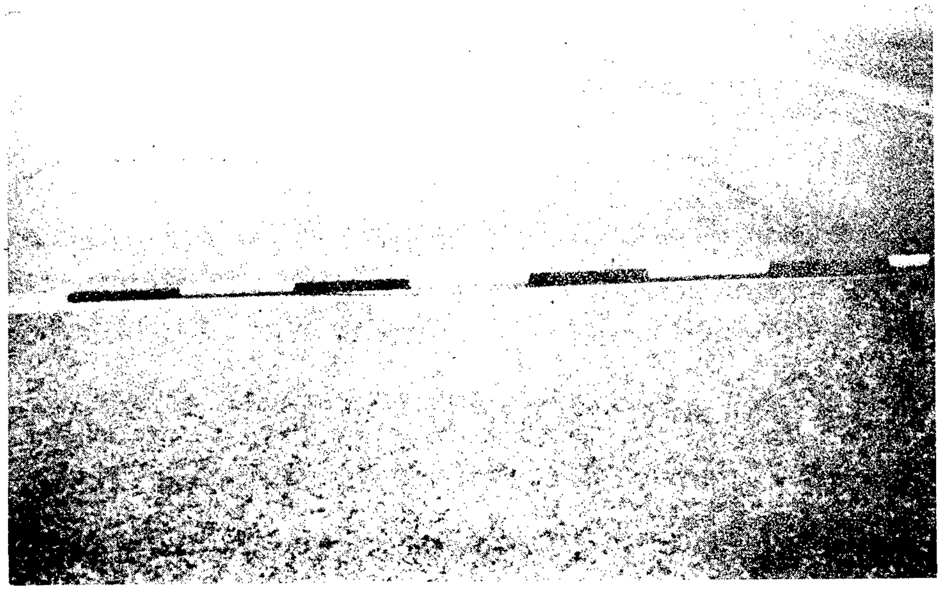


Figure B-57. Light severity rutting, case 1

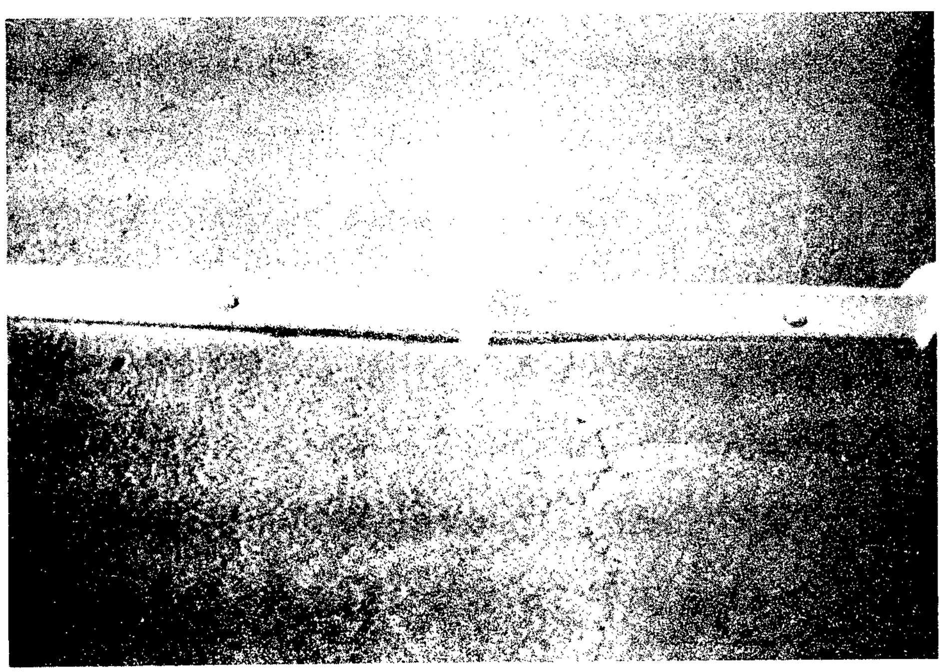


Figure B-58. Light severity rutting, case 2

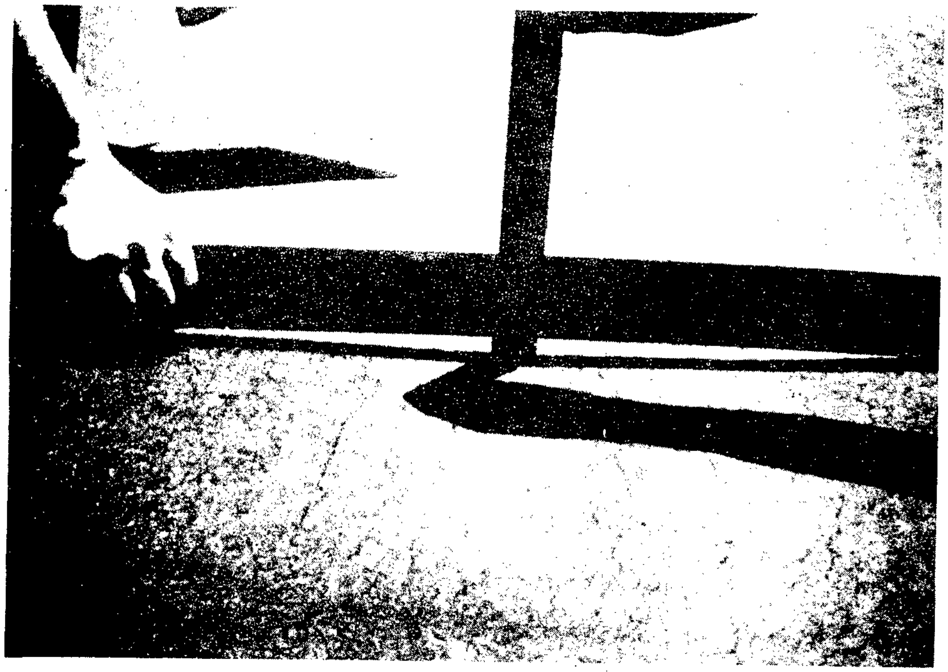


Figure B-59. Medium severity rutting

Figure B-60. High severity rutting (Note alligator cracking associated with rutting.)

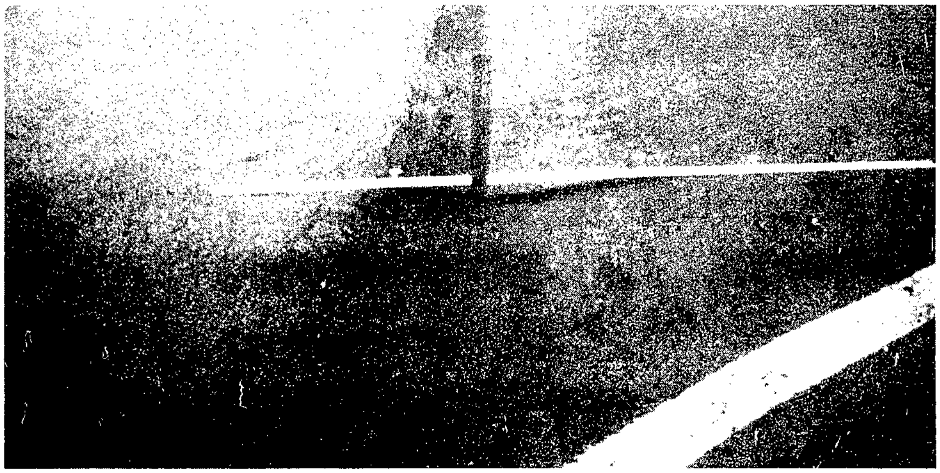


Figure B-61. High severity rutting (Note cracking and upheaval on sides of rut.)

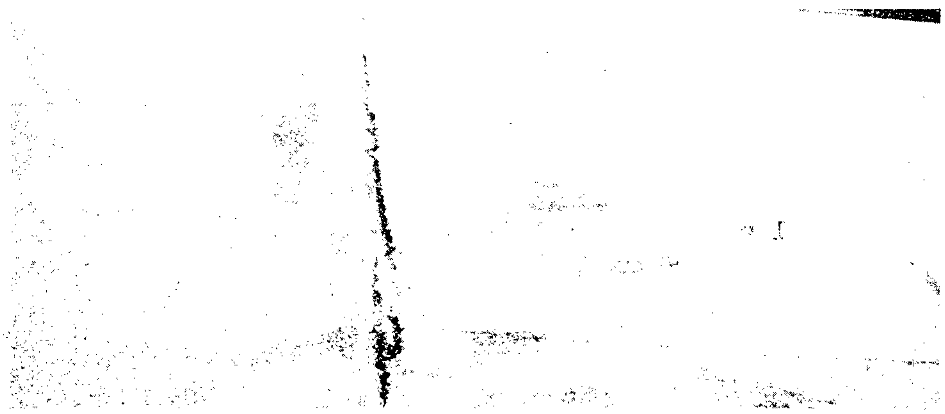


Figure B-62. Low severity shove on the outside and medium severity in the middle

Figure B-63. High severity shoving

SLIPPAGE CRACKING -
DISTRESS NO. 15

Description. Slippage cracks are crescent- or half-moon-shaped cracks having two ends pointed away from the direction of traffic. They are produced when braking or turning wheels cause the pavement surface to slide and deform. This usually occurs when there is a low strength surface mix or poor bond between the surface and next layer of pavement structure.

Severity Levels. No degrees of severity are defined. It is sufficient to indicate that a slippage crack exists (Figures B-64 and B-65).

Measuring Procedure. Slippage cracking is measured in square feet of surface area.

SWELL - DISTRESS NO. 16

Description. Swell is characterized by an upward bulge in the pavement's surface. A swell may occur sharply over a small area or as a longer, gradual wave. Either type of swell can be accompanied by surface cracking. A swell is usually caused by frost action in the subgrade or by swelling soil, but a small swell can also occur on the surface of an asphalt overlay (over PCC) as a result of a blowup in the PCC slab.

Severity Levels.

a. Low severity level (L). Swell is barely visible and has a minor effect on the pavement's ride quality as determined at the normal aircraft speed for the pavement section under consideration. (Low severity swells may not always be observable, but their existence can be confirmed by driving a vehicle over the section at the normal aircraft speed. An upward acceleration will occur if the swell is present.) (Figure B-66).

b. Medium severity level (M). Swell can be observed without difficulty and has a significant effect on the pavement's ride quality as determined at the normal aircraft speed for the pavement section under consideration (Figure B-67).

c. High severity level (H). Swell can be readily observed and severely affects the pavement's ride quality at the normal aircraft speed for the pavement section under consideration (Figures B-68 and B-69).

Figure B-64. Slippage cracking, case 1

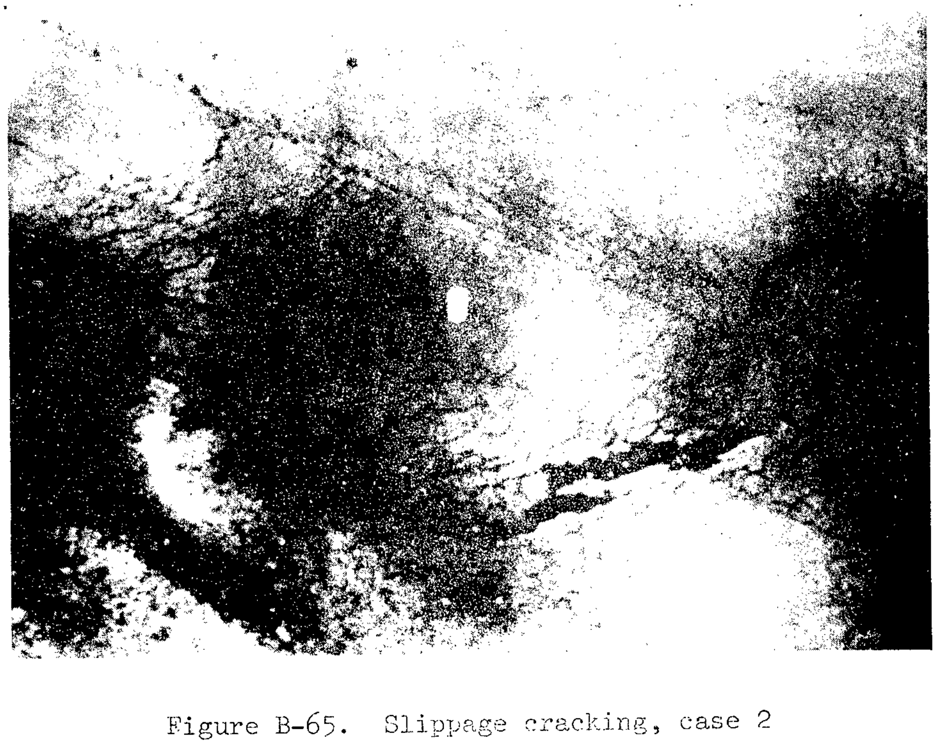


Figure B-65. Slippage cracking, case 2

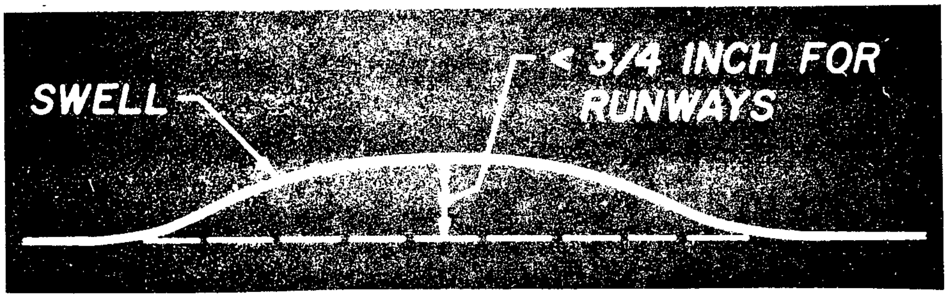


Figure B-66. Low severity swell

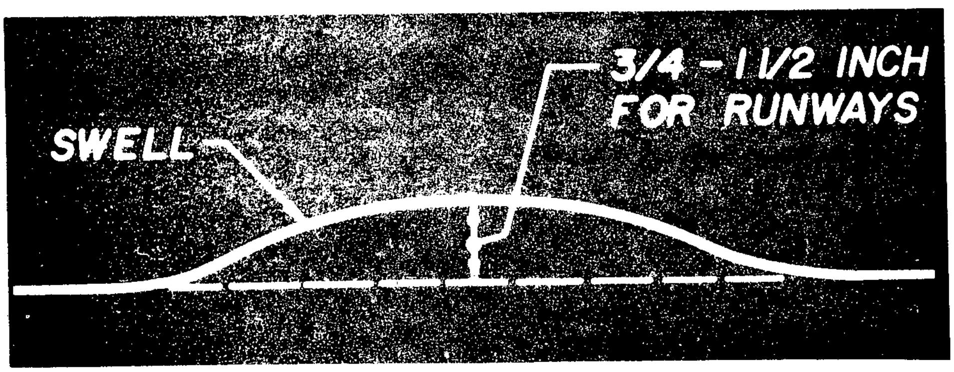


Figure B-67. Medium severity swell

Figure B-68. High severity swell

Figure B-69. High severity sharp swell

Measuring Procedure. The surface area of the swell is measured in square feet. The severity rating should consider the type of pavement section (i.e., runway, taxiway, or apron). For example, a swell of sufficient magnitude to cause considerable roughness on a runway at high speeds would be rated as more severe than the same swell located on an apron or taxiway where the normal aircraft operating speeds are much lower. The following guidance is provided for runways:

Severity	Height Differential
L	< 3/4 in.
M	3/4 - 1-1/2 in.
H	>1-1/2 in.

DISTRESSES ON JOINTED RIGID PAVEMENTS

BLOWUP - DISTRESS NO. 1

Description. Blowups occur in hot weather, usually at a transverse crack or joint that is not wide enough to permit expansion of the concrete slabs. The insufficient width is usually caused by infiltration of incompressible materials into the joint space. When expansion cannot relieve enough pressure, a localized upward movement of the slab edges (buckling) or shattering will occur in the vicinity of the joint. Blowups can also occur at utility cuts and drainage inlets. This type of distress is almost always repaired immediately because of severe damage potential to aircraft. The main reason blowups are included here is for reference when closed sections are being evaluated for reopening.

Severity Levels.

a. Low severity level (L). Buckling or shattering has not rendered the pavement inoperative, and only a slight amount of roughness exists (Figure B-70).

b. Medium severity level (M). Buckling or shattering has not rendered the pavement inoperative, but a significant amount of rougness exists (Figure B-71).

c. High severity level (H). Buckling or shattering has rendered the pavement inoperative (Figure B-72).

For the pavement to be considered operational, all foreign material caused by the blowup must have been removed.

Counting Procedure. A blowup usually occurs at a transverse crack or joint. At a crack, it is counted as being in one slab, but at a joint two slabs are affected and the distress should be recorded as occurring in two slabs.

CORNER BREAK - DISTRESS NO. 2

Description. A corner break is a crack that intersects the joints at a distance less than or equal to one-half of the slab length on both sides, measured from the corner of the slab. For example, a slab with dimensions of 25 by 25 ft that has a crack intersecting the joint 5 ft from the corner on one side and 17 ft on the other side is not considered a corner break; it is a diagonal crack. However, a crack that intersects 7 ft on one side and 10 ft on the other is considered a corner break. A corner break differs from a corner spall in that the crack extends vertically through the entire slab thickness, while a corner spall intersects the joint at an angle. Load repetition combined with loss of support and curling stresses usually cause corner breaks.

Figure B-70. Low severity blowup (Note that this would only be considered low severity if the shattering in the foreground was the only part existing and the foreign material removed.)

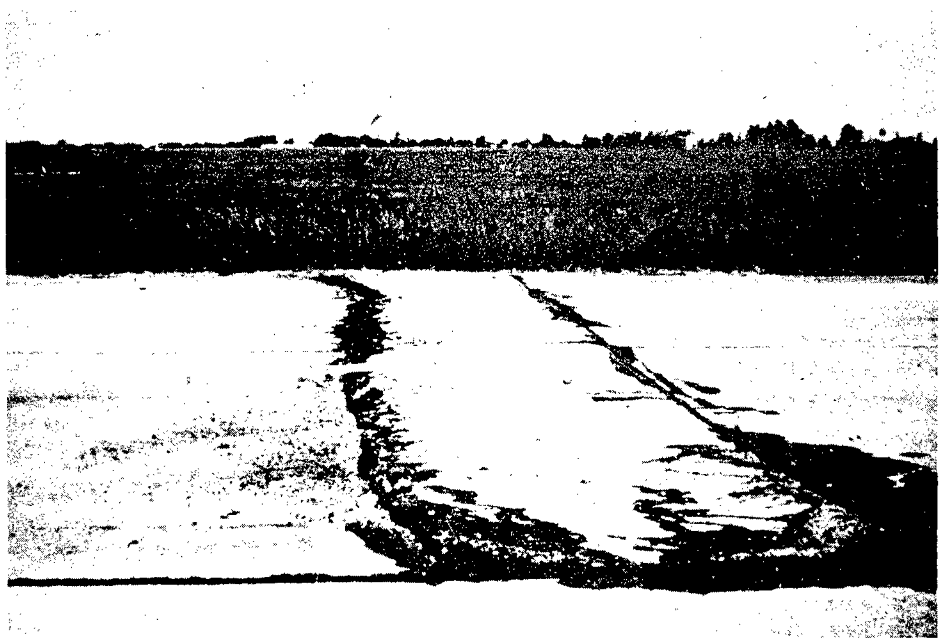


Figure B-71. Medium severity blowup

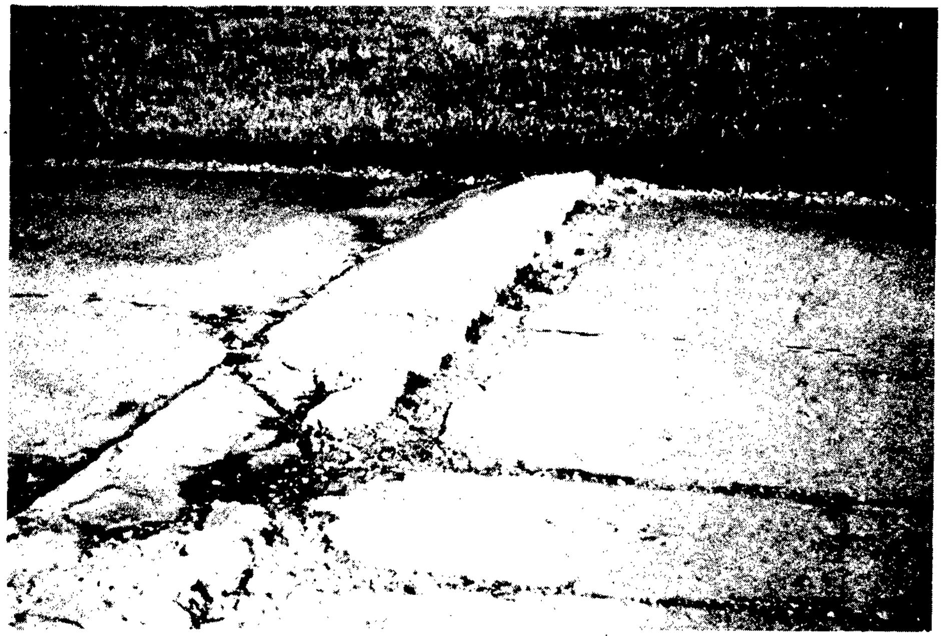


Figure B-72. High severity blowup

Severity Levels.

a. Low severity level (L). Crack has little or no spalling with no loose particles. If nonfilled, it has a mean width less than approximately 1/8 in. A filled crack can be of any width, but the filler material must be in satisfactory condition. The area between the corner break and the joints is not cracked (Figures B-73 and B-74).

b. Medium severity joint (M). One of the following conditions exists:

(1) Filled or nonfilled crack is moderately spalled with some loose particles.

(2) A nonfilled crack has a mean width between 1/8 and 1 in.

(3) A filled crack is not spalled or only lightly spalled, but the filler is in unsatisfactory condition.

(4) The area between the corner break and the joints is lightly cracked (Figures B-75 and B-76).

c. High severity level (H). One of the following conditions exists:

(1) Filled or nonfilled crack is severely spalled with loose and missing particles.

(2) A nonfilled crack has a mean width greater than approximately 1 in., creating a tire damage potential.

Figure B-73. Low severity corner break, case 1

Figure B-74. Low severity corner break, case 2

Figure B-75. Medium severity corner break, case 1 (Area between the corner break and the joint is lightly cracked.)

Figure B-76. Medium severity corner break, case 2

(3) The area between the corner break and the joints is severely cracked (Figure B-77).

Figure B-77. High severity corner break

Counting Procedure. A distress slab is recorded as one slab if it (a) contains a single corner break, (b) contains more than one break of a particular severity, or (c) contains two or more breaks of different severities. For two or more breaks, the highest level of severity should be recorded. For example, a slab containing both light and medium severity corner breaks should be counted as one slab with a medium corner break.

LONGITUDINAL, TRANSVERSE, AND
DIAGONAL CRACKS - DISTRESS NO. 3

Description. These cracks, which divide the slab into two or three pieces, are usually caused by a combination of load repetition, curling stresses, and shrinkage stresses. (For slabs divided into six or more pieces, see shattered/intersecting cracks.) Low severity cracks are usually warping- or friction-related and are not considered major structural distresses. Medium or high severity cracks are usually working cracks and are considered major structural distresses. (NOTE:

Hairline cracks that are only a few feet long and do not extend across the entire slab are rated as shrinkage cracks.)

Severity Levels.

a. Low severity level (L). Cracks have little or no spalling with no loose particles. If nonfilled, it is less than 1/8 in. wide. A filled crack can be of any width, but its filler material must be in satisfactory condition (Figures B-78 through B-80).

b. Medium severity level (M). One of the following conditions exists:

   (1) A filled or nonfilled crack is moderately spalled with some loose or missing particles.

   (2) A nonfilled crack has a mean width between 1/8 and 1 in.

   (3) A filled crack has no spalling or minor spalling, but the filler is in unsatisfactory condition.

   (4) The slab is divided into three pieces by low severity cracks (Figures B-81 through B-83).

c. High severity level (H). One of the following conditions exists:

   (1) A filled or nonfilled crack is severely spalled with loose and missing particles.

   (2) A nonfilled crack has a mean width approximately greater than 1 in., creating tire damage potential.

   (3) The slab is divided into three pieces by two or more cracks, one of which is at least of medium severity (Figures B-84 through B-86).

Counting Procedure. Once the severity has been identified, the distress is recorded as one slab.

DURABILITY ("D") CRACKING -
DISTRESS NO. 4

Description. Durability cracking is caused by the concrete's inability to withstand environmental factors such as freeze-thaw cycles. It usually appears as a pattern of cracks running parallel to a joint or linear crack. A dark coloring can usually be seen around the fine durability cracks. This type of cracking may eventually lead to disintegration of the concrete within 1 to 2 ft of the joint or crack.

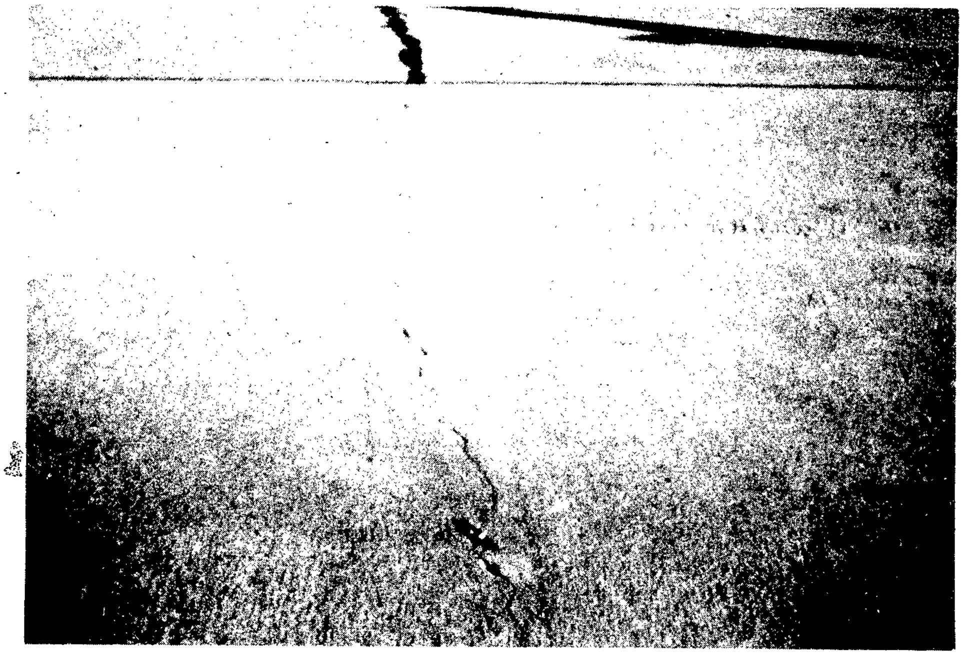


Figure B-78. Low severity longitudinal crack, jointed rigid pavement

Figure B-79. Low severity filled longitudinal cracks, jointed rigid pavement

Figure B-80. Low severity diagonal crack, jointed rigid pavement

Figure B-81. Medium severity longitudinal crack, jointed rigid pavement

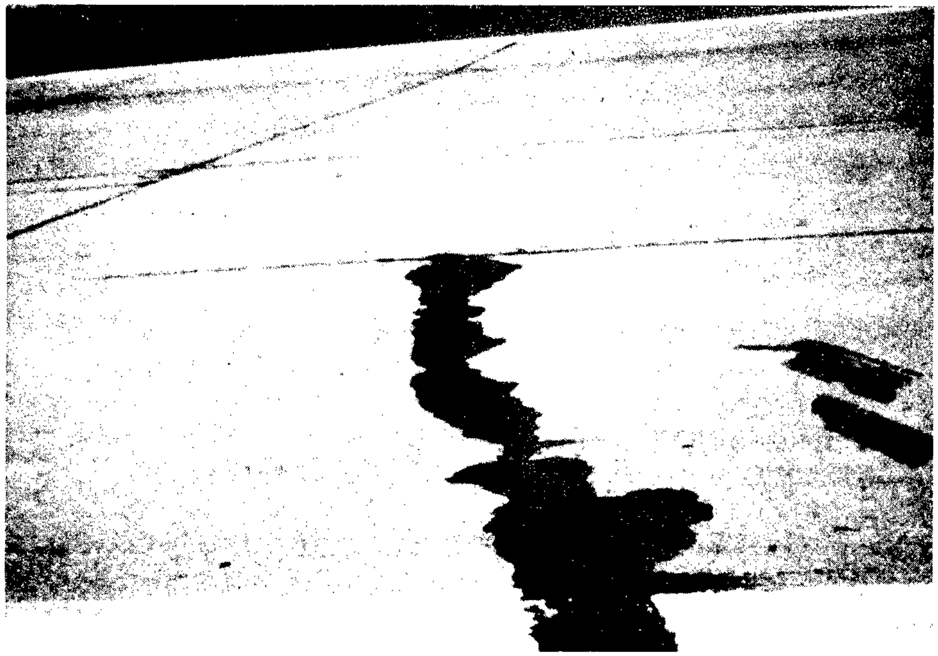


Figure B-82. Medium severity transverse crack, jointed rigid pavement, case 1

Figure B-83. Medium severity transverse crack, jointed rigid pavement case 2

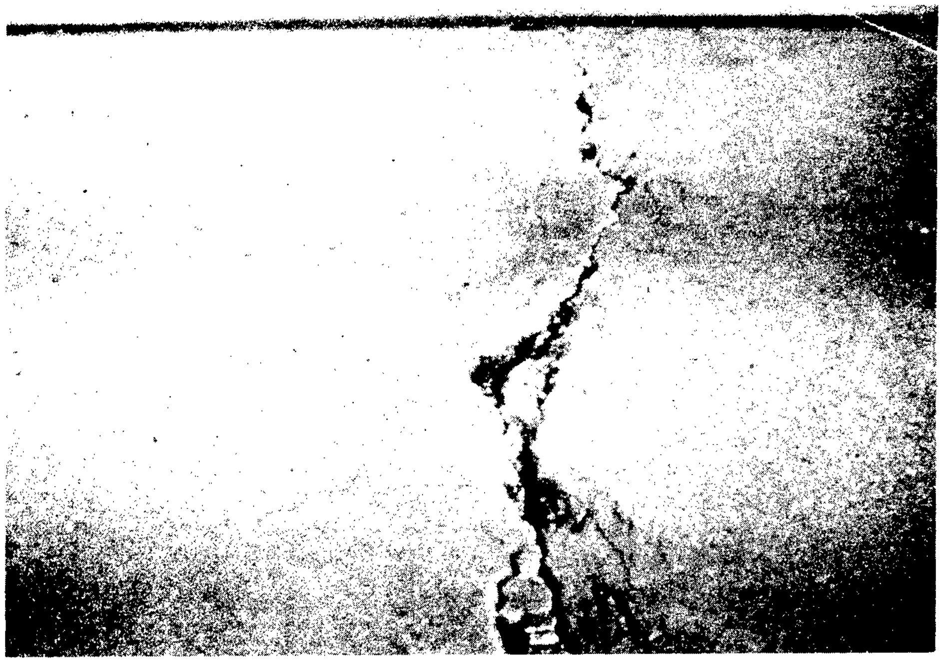


Figure B-84. High severity transverse crack, jointed rigid pavement

Figure B-85. High severity longitudinal crack, jointed rigid pavement, case 1

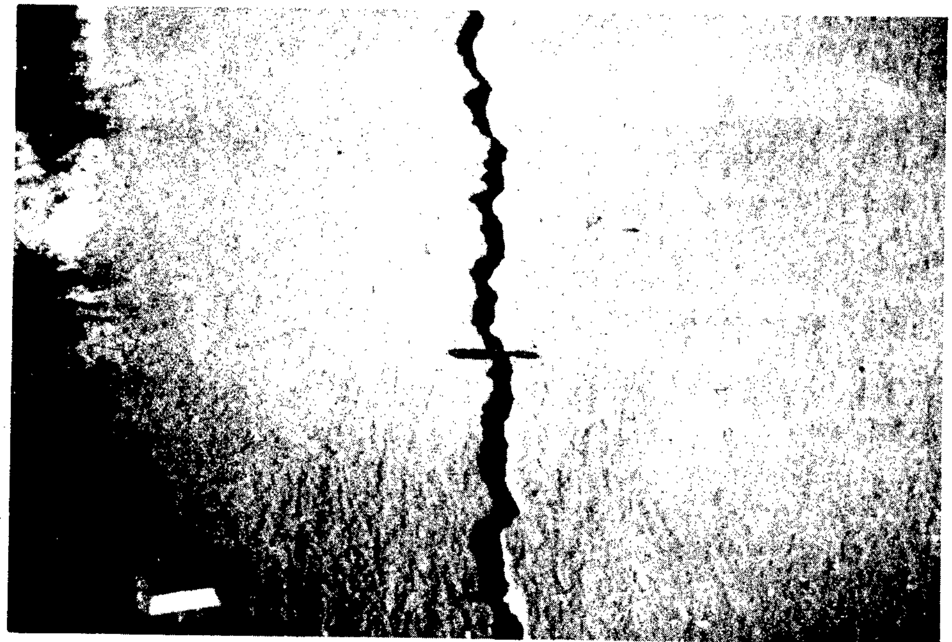


Figure B-86. High severity longitudinal crack, jointed rigid pavement, case 2

Severity Levels

a. Low severity level (L). Pieces are defined by light cracks and cannot be removed (Figure B-87).

Figure B-87. Low severity "D" cracking

b. Medium severity level (M). "D" cracks are well defined. Small pieces have been displaced (Figures B-88 and B-89).

Figure B-88. Medium severity "D" cracking, case 1

Figure B-89. Medium severity "D" cracking, case 2

c. High severity level (H). "D" cracking has developed over a considerable amount of slab area (greater than approximately one-quarter of the slab area), and the pieces are well defined and can be removed easily (Figure B-90).

Figure B-90. High severity "D" cracking (This condition exists over more than one-quarter of the slab.)

Counting Procedure. When the distress is located and rated at one severity, it is counted as one slab. If more than one severity level is found, the slab is counted as having the higher severity distress. For example, if light and medium durability cracking are located on one slab, the slab is counted as having medium only.

JOINT SEAL DAMAGE -
DISTRESS NO. 5

Description.

a. Joint seal damage is any condition which enables soil or rocks to accumulate in the joints or allows significant infiltration of water. Accumulation of incompressible materials prevents the slabs from expanding and may result in buckling, shattering, or spalling. A pliable joint filler bonded to the edges of the slabs protects the joints from accumulation of materials and also prevents water from seeping down and softening the foundation supporting the slab.

b. Typical types of joint seal damage are: stripping of joint sealant, extrusion of joint sealant, weed growth, hardening of the filler (oxidation), loss of bond to the slab edges, and lack or absence of sealant in the joint.

Severity Levels.

a. Low severity level (L). Joint sealer is in generally good condition throughout the section. Sealant is performing well with only a minor amount of any of the above types of damage present (Figure B-91).

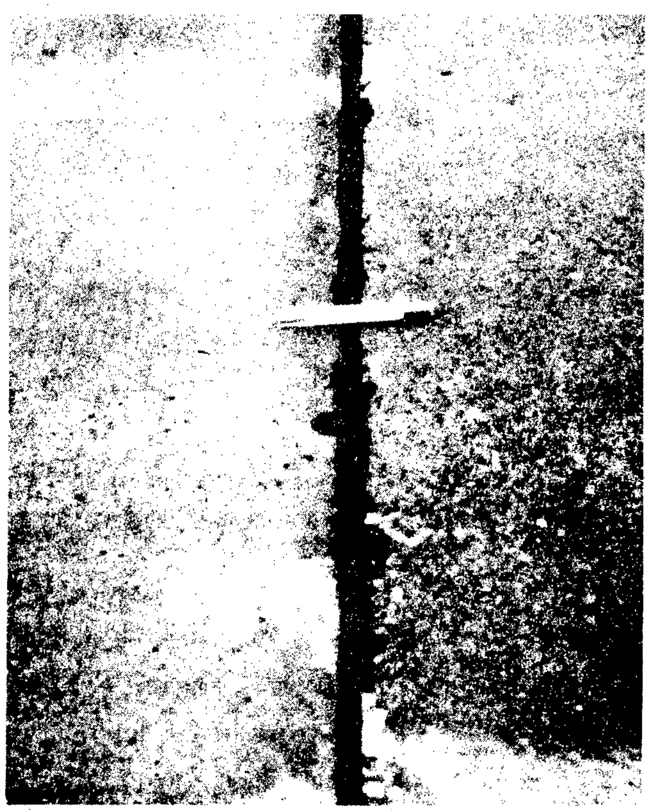


Figure B-91. Light severity joint seal damage (This condition existed only on a few joints in the pavement section. If all joint sealant were as shown, it would have been rated medium.)

b. Medium severity level (M). Joint sealer is in generally fair condition over the entire surveyed section with one or more of the above types of damage occurring to a moderate degree. Sealant needs replacement within 2 years (Figure B-92).

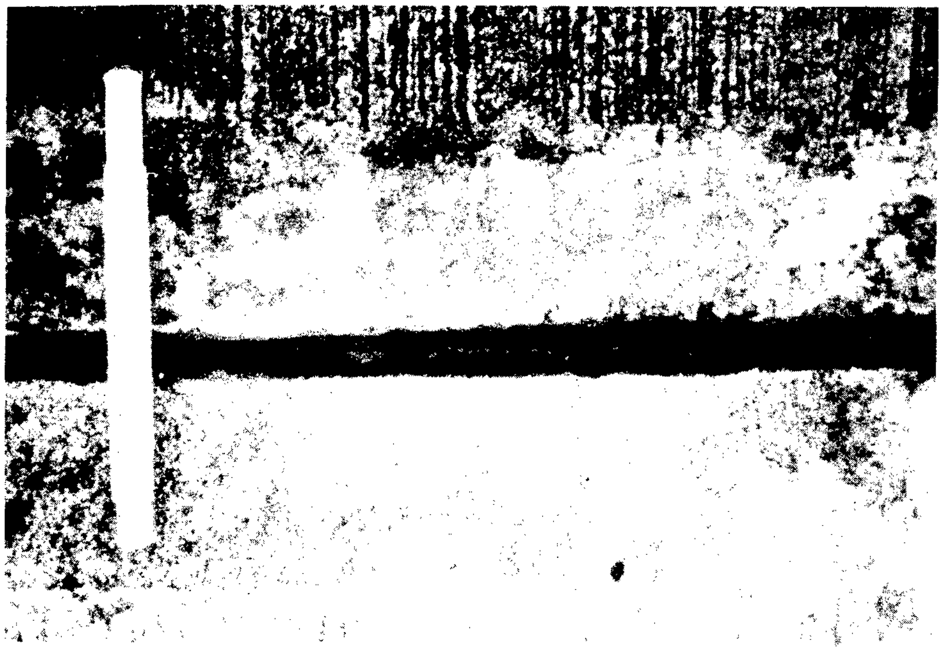


Figure B-92. Medium severity joint seal damage (Note that sealant has lost bond and is highly oxidized.)

c. High severity level (H). Joint sealer is in generally poor condition over the entire surveyed section with one or more of the above types of damage occurring to a severe degree. Sealant needs immediate replacement (Figures B-93 and B-94).

Counting Procedure. Joint seal damage is not counted on a slab-by-slab basis, but is rated based on the overall condition of the sealant over the entire section.

PATCHING, SMALL (LESS THAN 5 SQ FT) - DISTRESS NO. 6

Description. A patch is an area where the original pavement has been removed and replaced by a filler material. For condition evaluation, patching is divided into two types: small (less than 5 sq ft) and large (over 5 sq ft). Large patches are described in the next section.

Severity Levels.

a. Low severity level (L). Patch is functioning well with little or no deterioration (Figures B-95 and B-96).

b. Medium severity level (M). Patch has deteriorated and/or moderate spalling can be seen around the edges. Patch material can be dislodged with considerable effort (Figures B-97 and B-98).

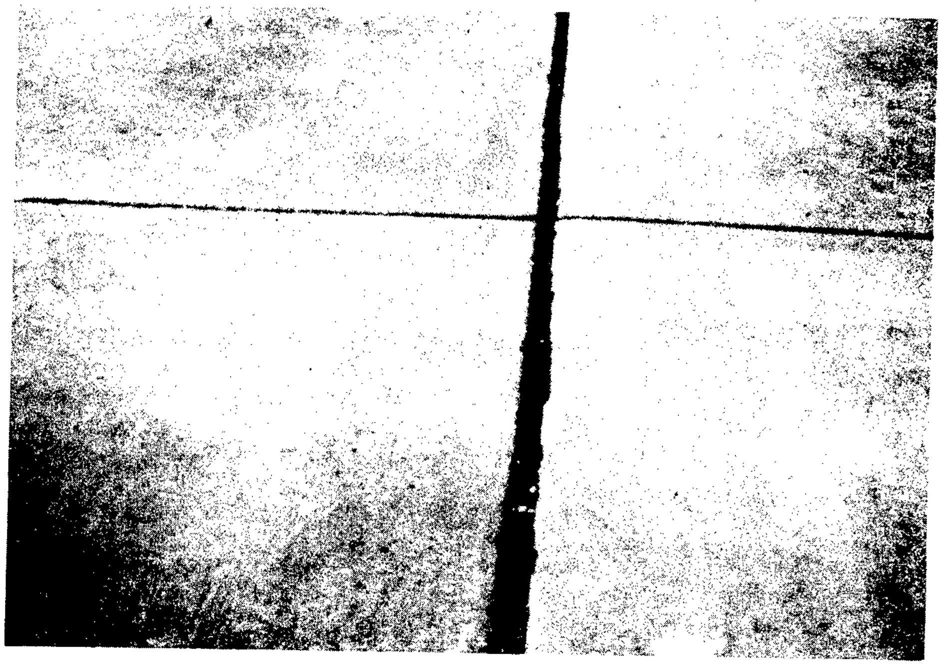


Figure B-93. High severity joint seal damage (complete loss of sealant; joint is filled with incompressible material)

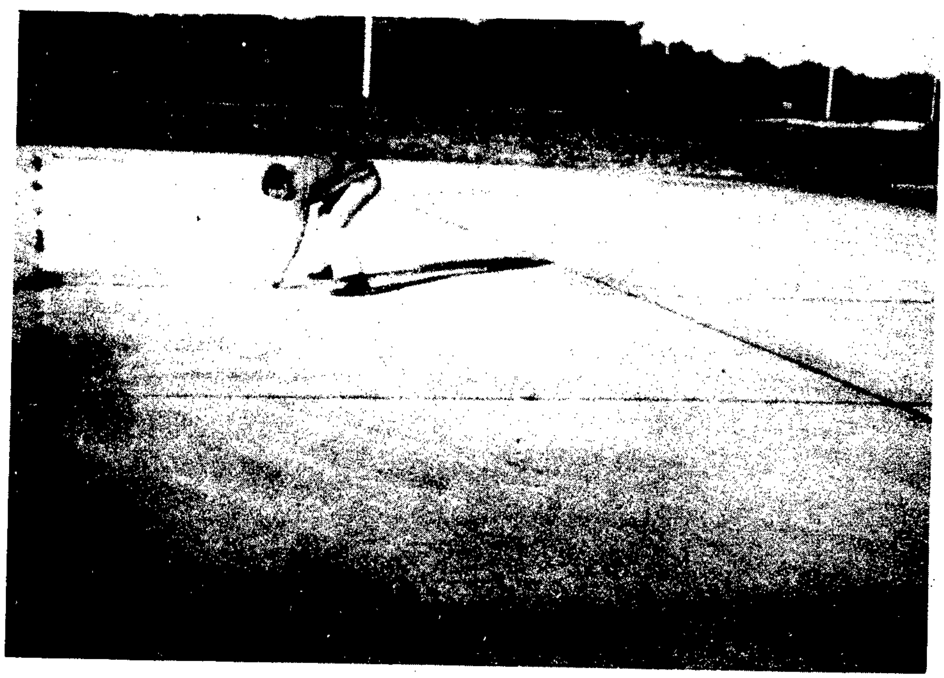


Figure B-94. High severity joint seal damage (extensive amount of weed growth)

Figure B-95. Low severity small patch, jointed rigid pavement, case 1

Figure B-96. Low severity small patch, jointed rigid pavement, case 2

Figure B-97. Medium severity small patch, jointed rigid pavement, case 1

Figure B-98. Medium severity small patch, jointed rigid pavement, case 2

c. <u>High severity level (H)</u>. Patch has deteriorated, either by spalling around the patch or cracking within the patch, to a state which warrants replacement (Figure B-99).

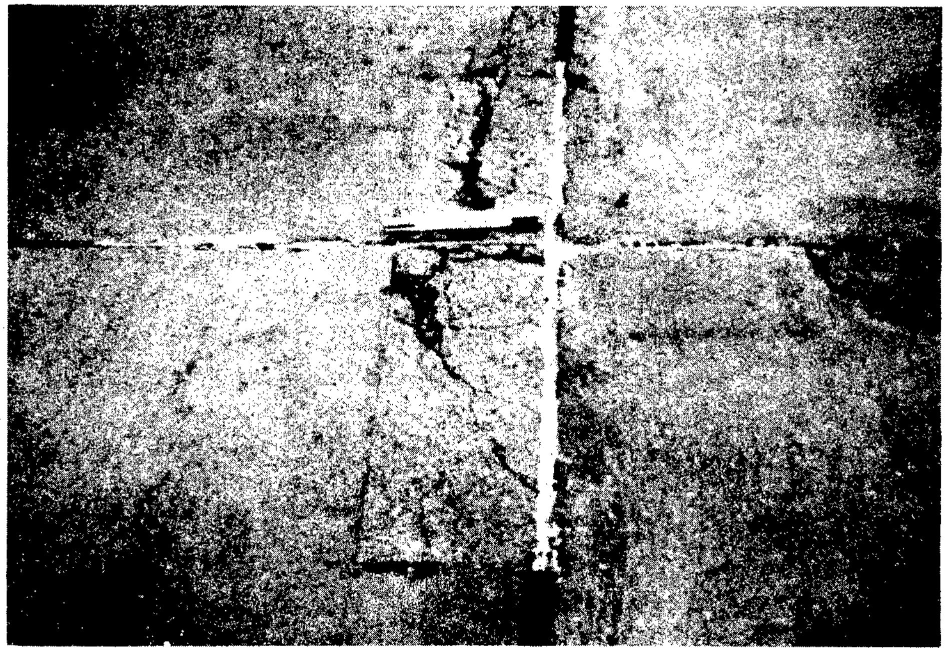


Figure B-99. High severity small patch, jointed rigid pavement

<u>Counting Procedure</u>. If one or more small patches having the same severity level are located in a slab, it is counted as one slab containing that distress. If more than one severity level occurs, it is counted as one slab with the higher severity level being recorded.

PATCHING, LARGE (OVER 5 SQ FT)
AND UTILITY CUT - DISTRESS NO. 7

<u>Description</u>. Patching is the same as defined in the previous section. A utility cut is a patch that has replaced the original pavement because of placement of underground utilities. The severity levels of a utility cut are the same as those for regular patching.

<u>Severity Levels</u>.

a. <u>Low severity level (L)</u>. Patch is functioning well with very little or no deterioration (Figures B-100 through B-102).

b. <u>Medium severity level (M)</u>. Patch is deteriorated and/or moderate spalling can be seen around the edges. Patch material can be dislodged with considerable effort (Figure B-103).

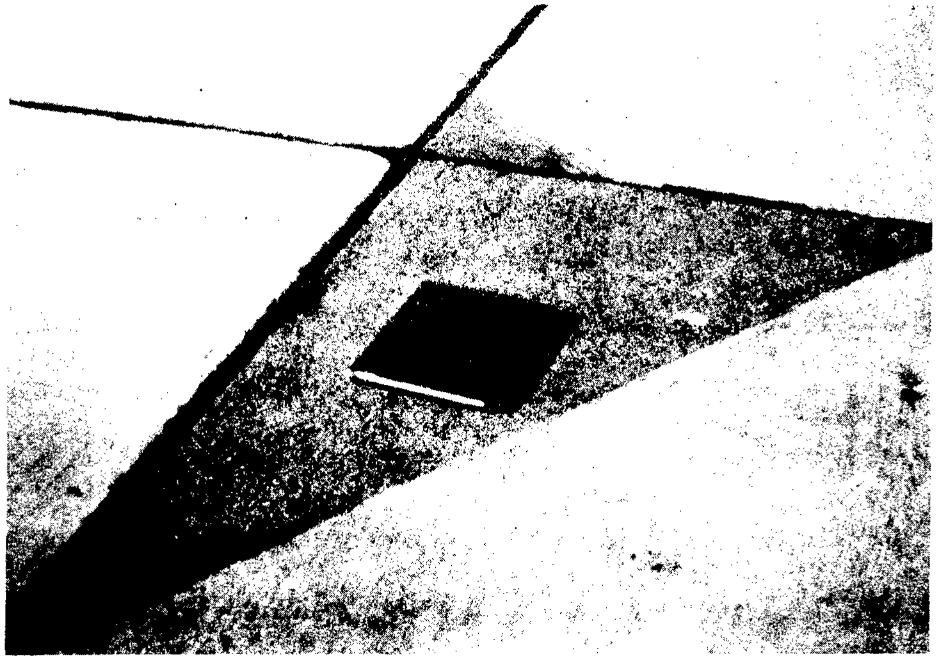


Figure B-100. Low severity patch, jointed rigid pavement, case 1

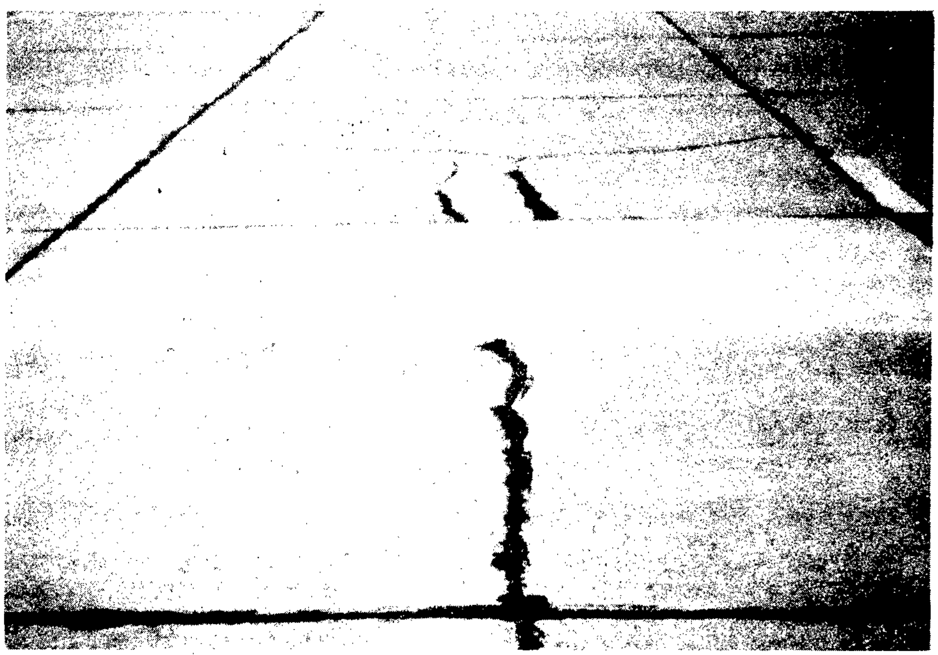


Figure B-101. Low severity patch, jointed rigid pavement, case 2

Figure B-102. Low severity utility cut

Figure B-103. Medium severity utility cut

c. High severity level (H). Patch has deteriorated to a state which causes considerable roughness with loose or easily dislodged material. The extent of the deterioration warrants replacement of the patch (Figure B-104).

Figure B-104. High severity patch, jointed rigid pavement

Counting Procedure. The criteria are the same as for small patches.

POPOUTS - DISTRESS NO. 8

Description. A popout is a small piece of pavement that breaks loose from the surface due to freeze-thaw action in combination with expansive aggregates. Popouts usually range from approximately 1 to 4 in. in diameter and from 1/2 to 2 in. deep.

Severity Levels. No degrees of severity are defined for popouts. However, popouts must be extensive before they are counted as a distress; i.e., average popout density must exceed approximately three popouts per square yard over the entire slab area (Figure B-105).

Counting Procedure. The density of the distress must be measured. If there is any doubt about the average being greater than three popouts per square yard, at least three random 1-sq-yd areas should be checked. When the average is greater than this density, the slab is counted.

Figure B-105. Popouts

PUMPING - DISTRESS NO. 9

Description. Pumping is the ejection of material by water through joints or cracks caused by deflection of the slab under passing loads. As the water is ejected, it carries particles of gravel, sand, clay, or silt resulting in a progressive loss of pavement support. Surface staining and base or subgrade material on the pavement close to joints or cracks are evidence of pumping. Pumping near joints indicates poor joint sealer and loss of support, which will lead to cracking under repeated loads.

Severity Levels. No degrees of severity are defined. It is sufficient to indicate the pumping exists (Figures B-106 through B-109).

Counting Procedure. Slabs are counted as follows (Figure B-110): one pumping joint between two slabs is counted as two slabs. However, if the remaining joints around the slab are also pumping, one slab is added per additional pumping joint.

Figure B-106. Pumping (Note fine material on surface that has been pumped out causing corner break.)

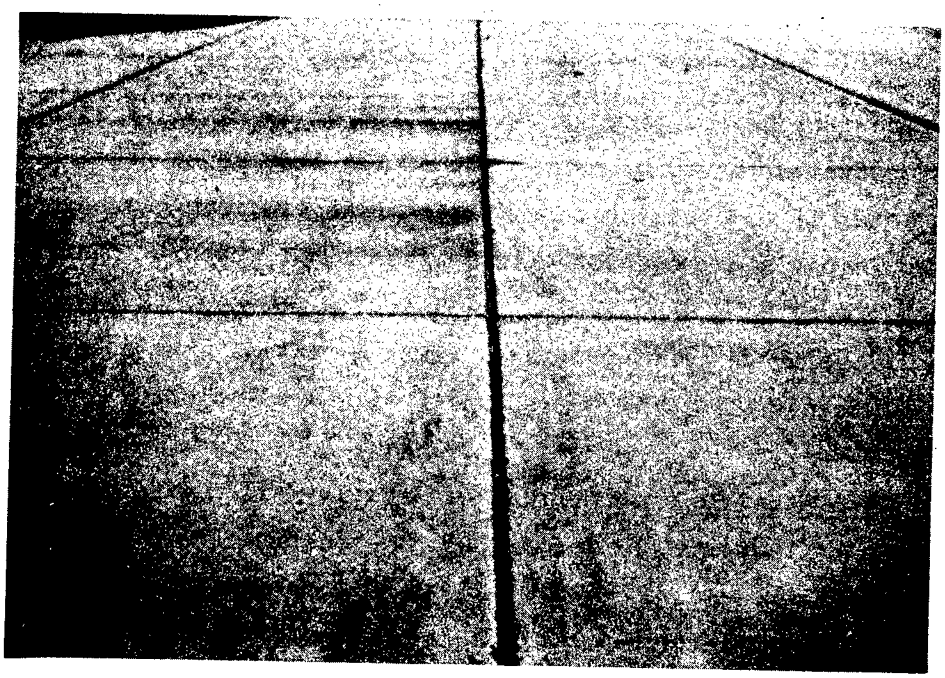


Figure B-107. Pumping (Note stains on pavement.)

Figure B-108. Pumping (close-up of fine materials collecting in the joint)

Figure B-109. Pumping

two slabs counted three slabs counted five slabs counted

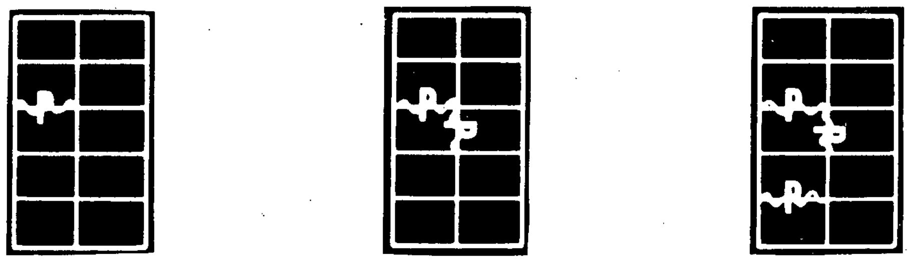


Figure B-110. Counting procedure for pumping

SCALING, MAP CRACKING, AND CRAZING - DISTRESS NO. 10

Description. Map cracking or crazing refers to a network of shallow, fine, or hairline cracks that extend only through the upper surface of the concrete. The cracks tend to intersect at angles of 120 degrees. Map cracking or crazing is usually caused by overfinishing the concrete and may lead to scaling of the surface, which is the breakdown of the slab surface to a depth of approximately 1/4 to 1/2 in. Scaling may also be caused by deicing salts, improper construction, freeze-thaw cycles, and poor aggregate. Another recognized source of distress is the reaction between the alkalies (Na_2O and K_2O) in some cements and certain minerals in some aggregates. Products formed by the reaction between the alkalies and aggregate result in expansions that cause a breakdown in the concrete. This generally occurs throughout the slab and not just at joints where "D" cracking normally occurs.

Severity Levels.

a. Low severity level (L). Crazing or map cracking exists over most of the slab area. The surface is in good condition with no scaling (Figure B-111). Note: The low severity level is an indicator that scaling may develop in the future.

b. Medium severity level (M). Slab is scaled over approximately 5 percent or less of the surface with some loose or missing material (Figure B-112).

c. High severity level (H). Slab is severely scaled with a large amount of loose or missing material. Usually, more than 5 percent of the surface is affected (Figures B-113 and B-114).

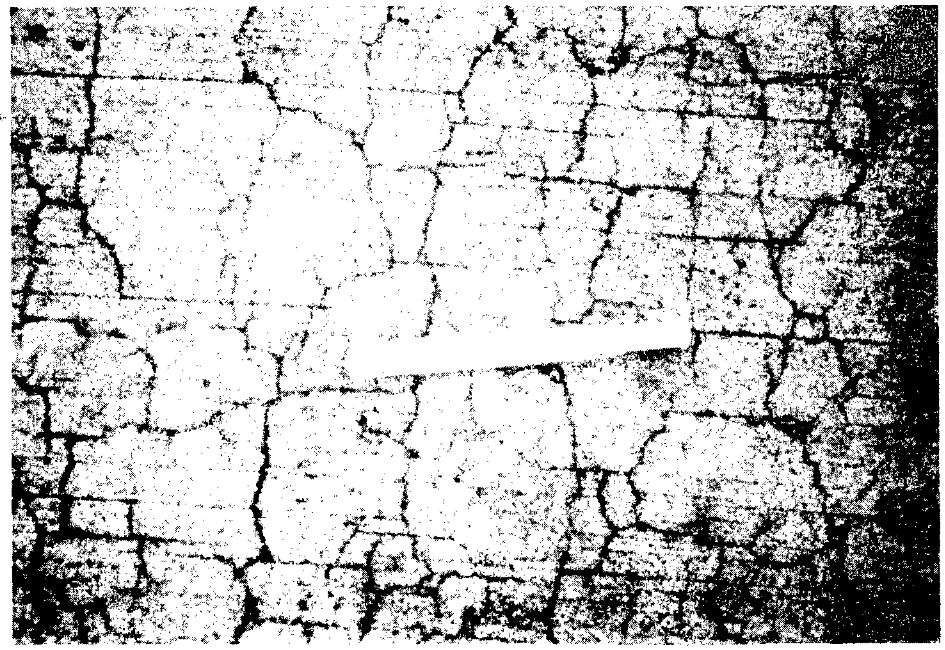


Figure B-111. Low severity crazing

Figure B-112. Medium severity scaling

Figure B-113. High severity scaling

Figure B-114. Close-up of high severity scaling

Counting Procedure. If two or more levels of severity exist on a slab, the slab is counted as one slab having the maximum level of severity. For example, if both low severity crazing and medium scaling exist on one slab, the slab is counted as one slab containing medium scaling.

SETTLEMENT OR FAULTING -
DISTRESS NO. 11

Description. Settlement or faulting is a difference of elevation at a joint or crack caused by upheaval or consolidation.

Severity Levels. Severity levels are defined by the difference in elevation across the fault and the associated decrease in ride quality and safety as severity increases.

Difference in Elevation

	Runways/Taxiways	Aprons
L	< 1/4 in.	1/8 ≤ 1/2 in. (Figures B-115 and B-116)
M	1/4-1/2 in.	1/2-1 in. (Figure B-117)
H	> 1/2 in. (Figures B-118 and B-119)	> 1 in.

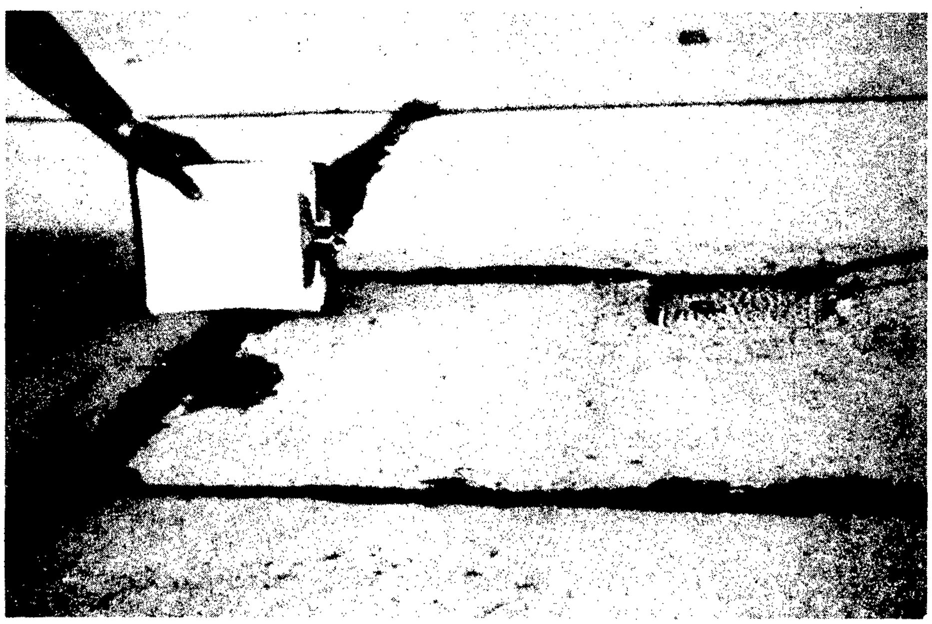


Figure B-115. Low severity settlement (3/8 in.) on apron, case 1

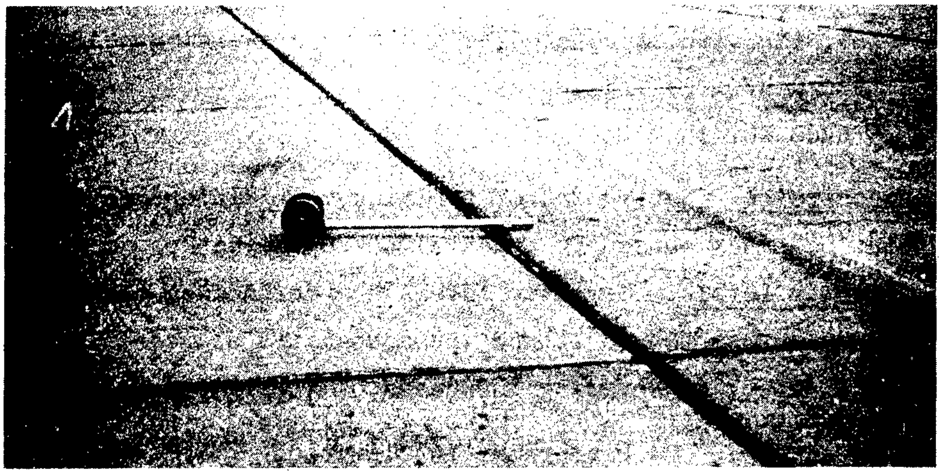


Figure B-116. Low severity settlement on apron, case 2

Figure B-117. Medium severity settlement on apron (> 1/2 in.)

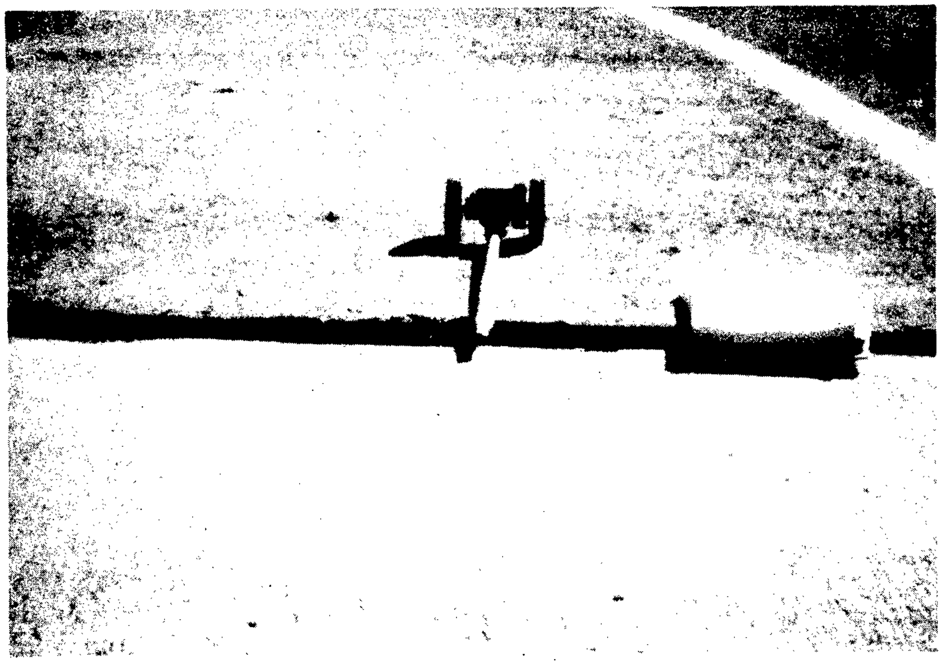


Figure B-118. High severity settlement on taxiway/runway (3/4 in.), case 1

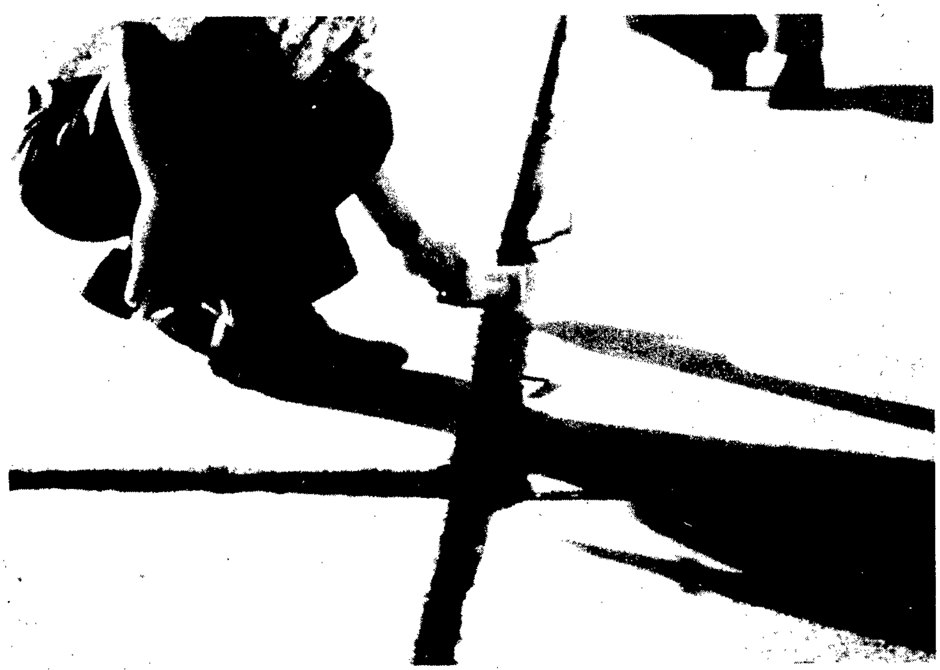


Figure B-119. High severity settlement, case 2

Counting Procedure. In counting settlement, a fault between two slabs is counted as one slab (Figure B-120). A straightedge or level should be used to aid in measuring the difference in elevation between the two slabs (Figure B-117).

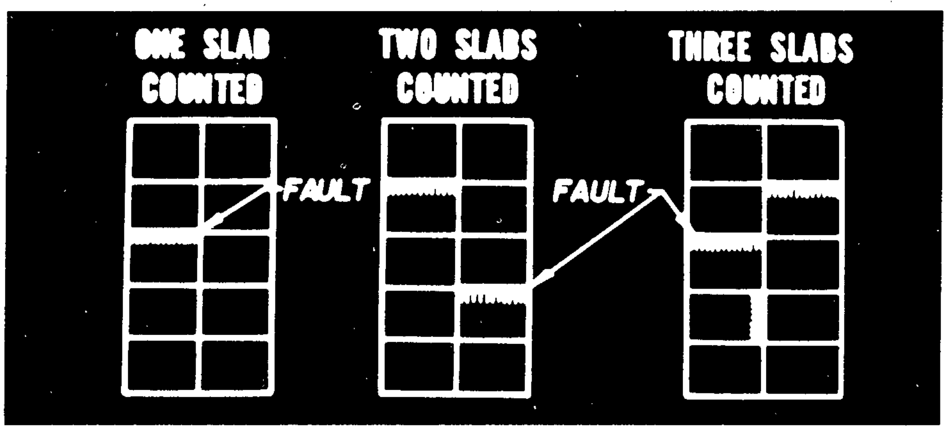


Figure B-120. Counting procedure for settlement or faulting

SHATTERED SLAB/INTERSECTING CRACKS - DISTRESS NO. 12

Description. Intersecting cracks are cracks that break the slab into four or more pieces due to overloading and/or inadequate support. The high severity level of this distress type, as defined below, is referred to as shattered slab. If all pieces or cracks are contained within a corner break, the distress is categorized as a severe corner break.

Severity Levels.

a. Low severity level (L). Slab is broken into four or five pieces with some or all cracks of low severity (Figures B-121 and B-122).

b. Medium severity level (M).

(1) Slab is broken into four or five pieces with some or all cracks of medium severity (no high severity cracks).

(2) Slab is broken into six or more pieces with all cracks of low severity (Figures B-123 and B-124).

c. High severity level (H). At this level of severity, the slab is called shattered.

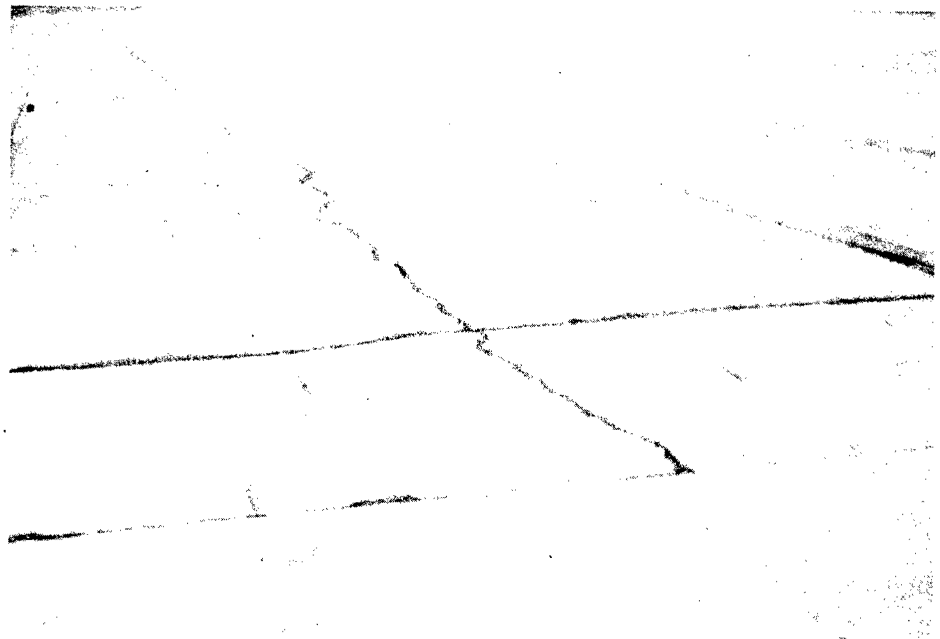


Figure B-121. Low severity intersecting cracks, case 1

Figure B-122. Low severity intersecting cracks, case 2

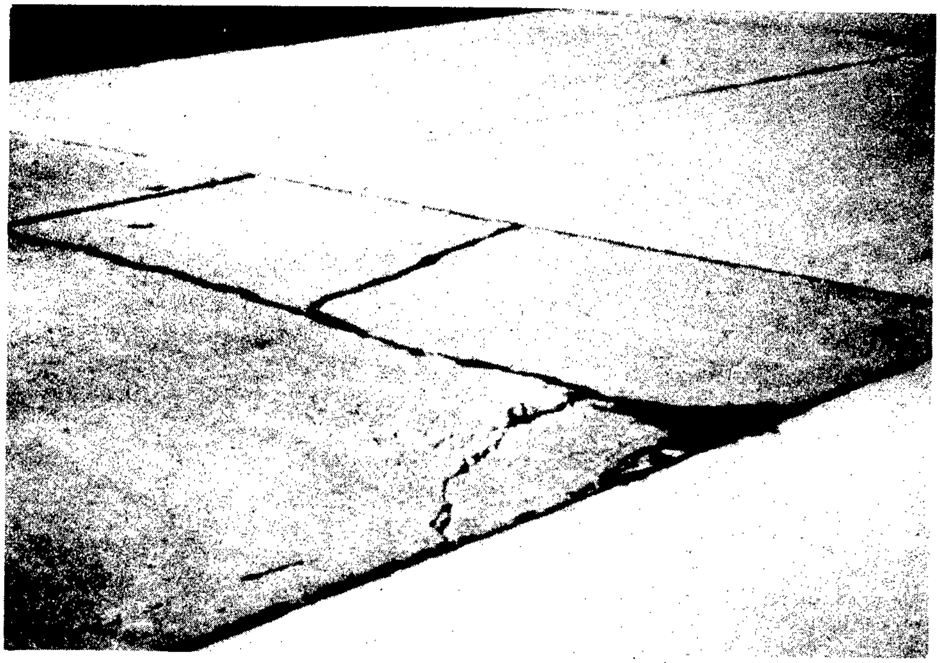


Figure B-123. Medium severity intersecting cracks, case 1

Figure B-124. Medium severity intersecting cracks, case 2

(1) Slab is broken into four or five pieces with some or all cracks of high severity.

(2) Slab is broken into six or more pieces with some or all cracks of medium or high severity (Figure B-125).

Figure B-125. Shattered slab

Counting Procedure. If a slab is rated as medium or high severity level shattered slab, then no other distress type should be counted in the slab. The deduct values for shattered slab distress are high since this condition is essentially failure; therefore, the counting of other distress types in the slab would tend to underrate the PCI of the sample unit.

SHRINKAGE CRACKS - DISTRESS NO. 13

Description. Shrinkage cracks are hairline cracks that are usually only a few feet long and do not extend across the entire slab. They are formed during the setting and curing of the concrete and usually do not extend through the depth of the slab.

Severity Levels. No degrees of severity are defined. It is sufficient to indicate that shrinkage cracks exist (Figures B-126 through B-128).

Figure B-126. Shrinkage crack, case 1

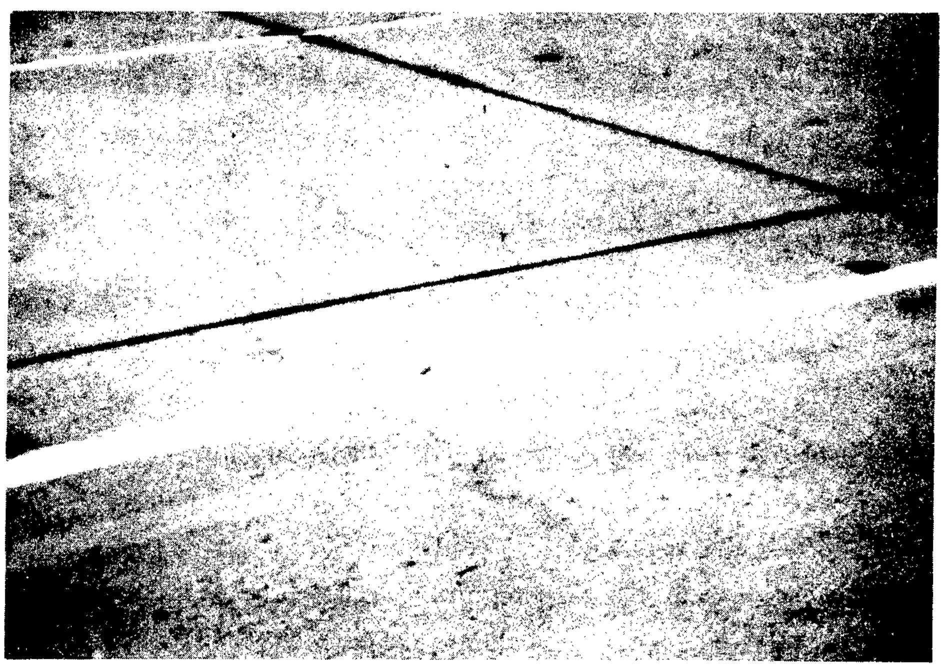


Figure B-127. Shrinkage crack, case 2

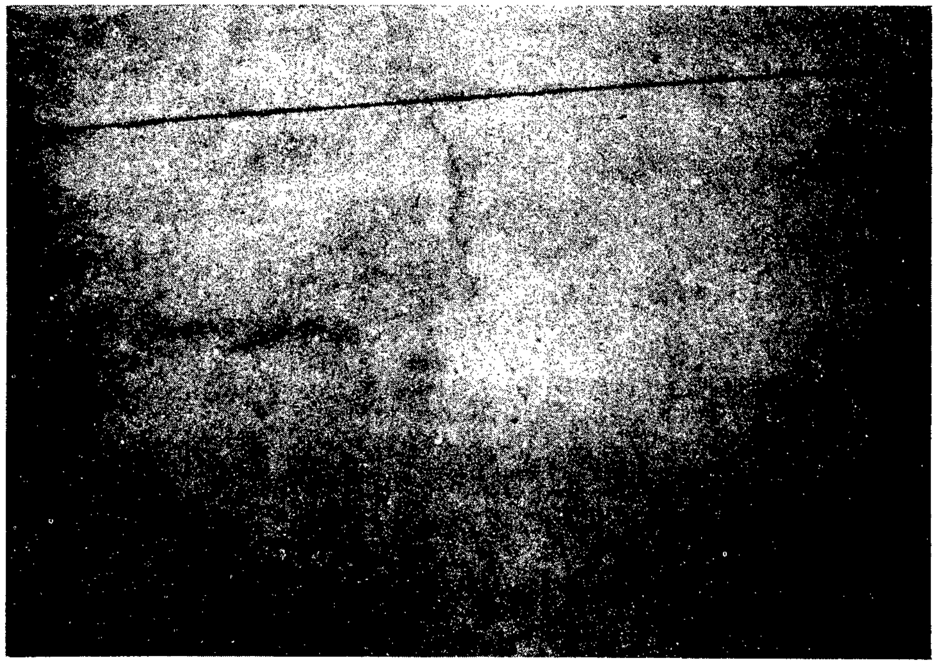


Figure B-128. Shrinkage crack, case 3

Counting Procedure. If one or more shrinkage cracks exist on one particular slab, the slab is counted as one slab with shrinkage cracks.

SPALLING (TRANSVERSE AND LONGI-
TUDINAL JOINT) - DISTRESS NO. 14

Description. Joint spalling is the breakdown of the slab edges within 2 ft of the side of the joint. A joint spall usually does not extend vertically through the slab but intersects the joint at an angle. Spalling results from excessive stresses at the joint or crack caused by infiltration of incompressible materials or traffic load. Weak concrete at the joint (caused by overworking) combined with traffic loads is another cause of spalling.

Severity Levels.

a. Low severity level (L).

(1) Spall over 2 ft long:

(a) Spall is broken into no more than three pieces defined by low or medium severity cracks.

(b) Joint is lightly frayed either with little, if any, loose or missing material.

(2) Spall less than 2 ft long is broken into pieces or fragmented with little loose or missing material or tire damage potential (Figures B-129 through B-131).

Figure B-129. Low severity joint spall, case 1

Figure B-130. Low severity joint spalling, case 2 (If the frayed area was less than 2 ft long, it would not be counted.)

Figure B-131. Low severity joint spall, case 3.

b. Medium severity level (M).

(1) Spall over 2 ft long:

(a) Spall is broken into more than three pieces defined by light or medium cracks.

(b) Spall is broken into no more than three pieces with one or more of the cracks being severe with some loose or missing material.

(c) Joint is moderately frayed with some loose or missing material.

(2) Spall less than 2 ft long is broken into pieces or fragmented with some of the pieces loose or absent with some tire damage potential (Figures B-132 and B-133).

c. High severity level (H). Spall over 2 ft long:

(1) Spall is broken into more than three pieces defined by one or more high severity cracks with high possibility of the pieces becoming dislodged.

(2) Joint is severely frayed with a large amount of loose or missing particles (Figures B-134 and B-135).

Note: If less than 2 ft of the joint is lightly frayed, the spall should not be counted.

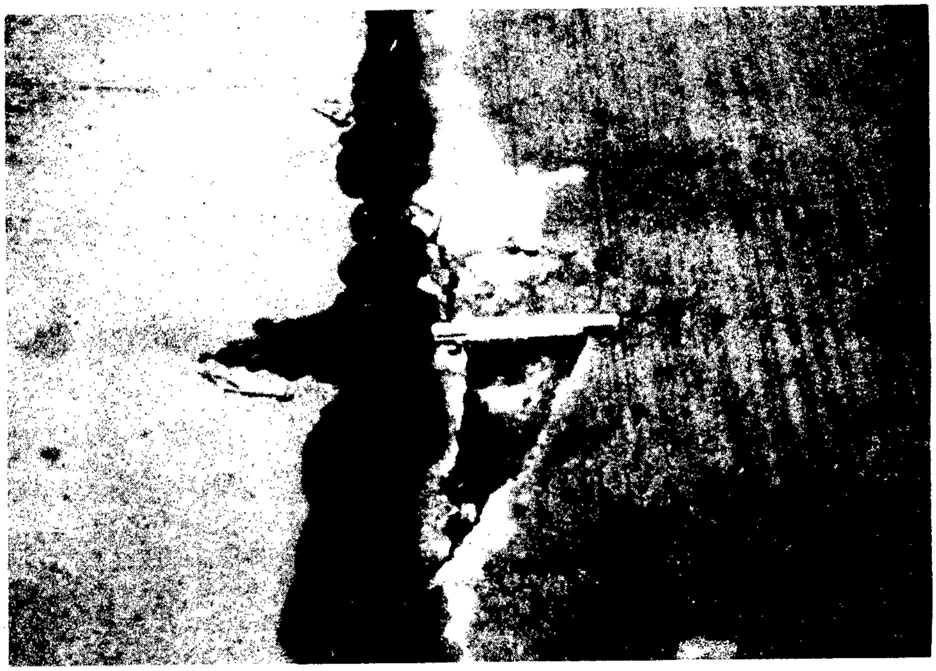


Figure B-132. Medium severity joint spall, case 1

Figure B-133. Medium severity joint spall, case 2

Figure B-134. High severity joint spall, case 1

Figure B-135. High severity joint spall, case 2

Counting Procedure. If the joint spall is located along the edge of one slab, it is counted as one slab with joint spalling. If spalling is located on more than one edge of the same slab, the edge having the highest severity is counted and recorded as one slab. Joint spalling can also occur along the edges of two adjacent slabs. If this is the case, each slab is counted as having joint spalling.

SPALLING (CORNER) -
DISTRESS NO. 15

Description. Corner spalling is the raveling or breakdown of the slab within approximately 2 ft of the corner. A corner spall differs from a corner break in that the spall usually angles downward to intersect the joint, while a break extends vertically through the slab.

Severity Levels.

a. Low severity level (L). One of the following conditions exists:

(1) Spall is broken into one or two pieces defined by low severity cracks. Pieces are not easily dislodged.

(2) Spall is defined by one medium severity crack with the material secured in place (Figures B-136 and B-137).

Figure B-136. Low severity corner spall, case 1

Figure B-137. Low severity corner spall, case 2

b. Medium severity level (M). One of the following conditions exists:

(1) Spall is broken into two or more pieces defined by medium severity crack(s), and a few small fragments may be absent or loose.

(2) Spall is defined by one severe, fragmented crack that may be accompanied by a few hairline cracks.

(3) Spall has deteriorated to the point where loose material exists (Figures B-138 and B-139).

c. High severity level (H). One of the following conditions exists:

(1) Spall is broken into two or more pieces defined by high severity fragmented crack(s) with loose or absent fragments.

(2) Pieces of the spall have been displaced to the extent that a tire damage hazard exists (Figures B-140 and B-141).

Counting Procedure. If one or more corner spalls having the same severity level are located in a slab, the slab is counted as one slab with corner spalling. If more than one severity level occurs, it is counted as one slab having the higher severity level.

Figure B-138. Medium severity corner spall, case 1

Figure B-139. Medium severity corner spall, case 2

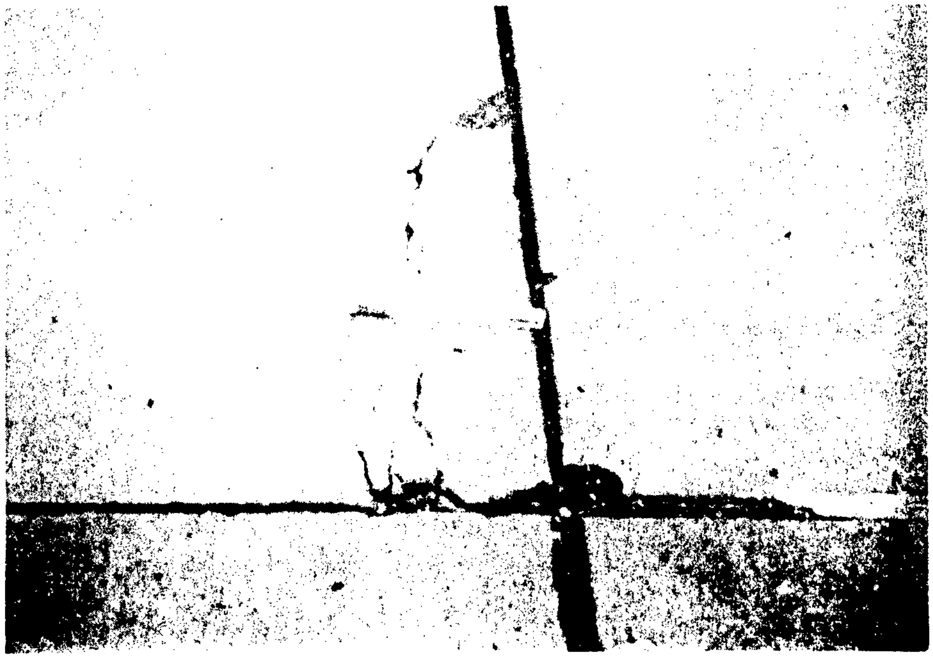


Figure B-140. High severity corner spall, case 1

Figure B-141. High severity corner spall, case 2

APPENDIX C. BIBLIOGRAPHY

"Maintenance of Joints and Cracks in Concrete Pavement," IS188.01P, Portland Cement Association, Skokie, Illinois 60077, 1976.

"Patching Concrete Pavement," IS189.01P, Portland Cement Association, Skokie, Illinois 60077, 1976.

"Slabjacking Concrete Pavements," IS060.01P, Portland Cement Association, Skokie, Illinois 60077, 1967.

"Asphalt in Pavement Maintenance," MS-16, The Asphalt Institute, College Park, Maryland 20740, 1977.

"Maintenance and Repair of Surface Areas," TM 5-624, MO-102, AFR 85-8, Departments of the Army, Navy, and Air Force, Washington, D.C., 1977.

"Pavement Rehabilitation Materials and Techniques," Synthesis of Highway Practice 9, National Cooperative Highway Research Program, Washington, D.C., 1972.

"Sealing Joints and Cracks, Thin Resurfacing, and Locating Voids Under Concrete Slabs," Transportation Research Record 752, Transportation Research Board, Washington, D.C., 1980.

Hall, J.W. and Elsa, D.R., "Procedure for Condition Survey of Civil Airports," U.S. Army Engineer Waterways Experimental Station, Vicksburg, Mississippi, 1979.

Report No. CEEDO-TR-77-44-VOL-1, "Development of a Pavement Maintenance Management System, Volume I: Maintenance and Repair Guidelines for Airfield Pavements," Construction Engineering Research Laboratory, Champaign, Illinois, December 1977.

Report No. CEEDO-TR-77-44-VOL-2, "Development of a Pavement Maintenance Management System, Volume II: Airfield Pavement Distress Identification Manual," Construction Engineering Research Laboratory, Champaign, Illinois, December 1977.

Report No. CEEDO-TR-77-44-VOL-3, "Development of a Pavement Maintenance Management System, Volume III: Maintenance and Repair Guidelines for Airfield Pavements," Construction Engineering Research Laboratory, Champaign, Illinois, September 1977.

Report No. CEEDO-TR-77-44-VOL-4, "Development of a Pavement Maintenance Management System, Volume IV: Appendices A Through I, Maintenance and Repair Guidelines for Airfield Pavements," Construction Engineering Research Laboratory, Champaign, Illinois, September 1977.

Report No. FAA-RD-75-110-II, Methodology for Determining, Isolating, and Correcting Runway Roughness, June 1977.

Report No. FAA-RD-80-55, Procedures for Condition Survey of Civil Airports, May 1980.

AC 150/5320-5, Airport Drainage, current edition.

AC 150/5320-12, Methods for the Design, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces, current edition.

AC 150/5370-11, Use of Nondestructive Testing Devices in the Evaluation of Airport Pavements, current edition.